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**Why Kids Flip  
Over  
Space Camp**

# AIR & SPACE

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Smithsonian June/July 1992



**THE PRIVATE LIVES  
OF  
MILITARY JETS**

***Thirteen  
Unlucky  
Airplanes***





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Smithsonian



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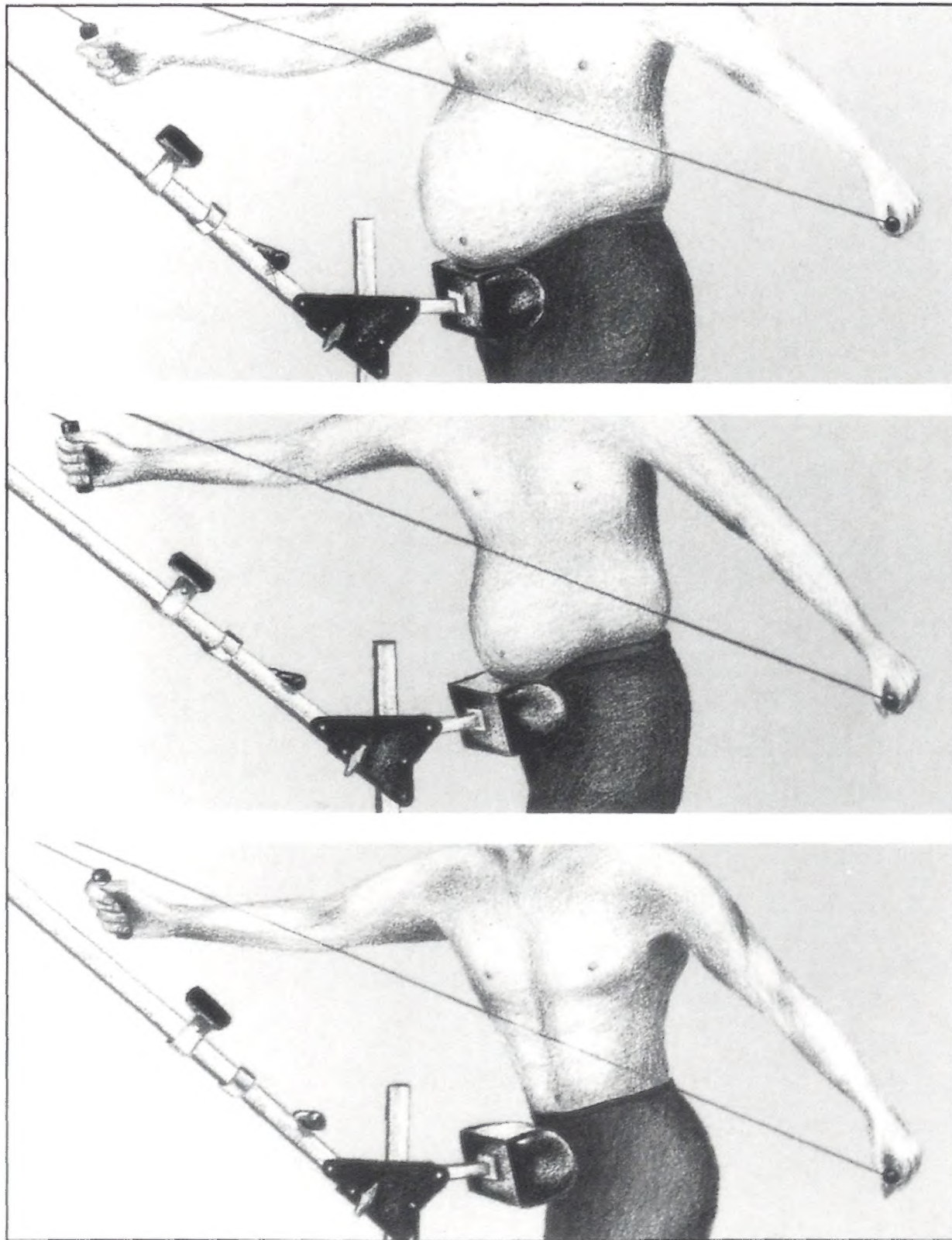
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# AIR & SPACE

Smithsonian

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## FLYING EXCELLENCE: ROLEX AND THE EAGLES

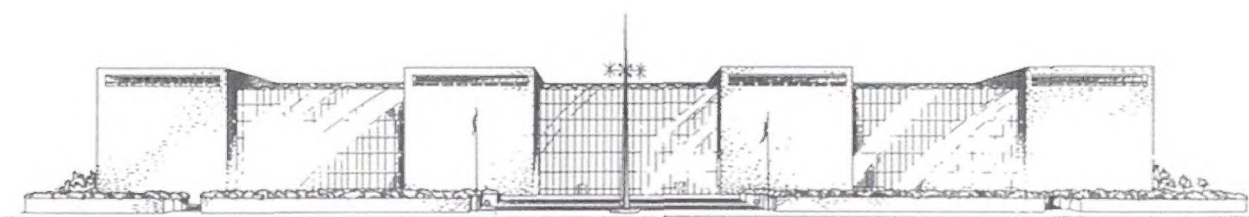
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## Clarity of Goals

We keep being told that the country needs more scientists and engineers, and that our schools are falling behind.

But then I stumble on a report in *Physics Today* that says recently graduated Ph.D. physicists are having difficulties finding jobs, while colleagues who have lost their jobs in mid-career are leaving the field. And a survey by the American Institute of Physics notes that recent graduates with bachelor degrees in physics are also having difficulties in finding jobs related to their expertise. Elsewhere, mathematicians and chemists have reported being out of work, while industry and government laboratories are cutting back on basic as well as applied research. And leading liberal arts colleges are sometimes flooded with hundreds of applications for every open job, while other institutions are instating hiring freezes.

Even in such rapidly expanding, highly technical sectors of the economy as microelectronics and the computer industry, the number of workers has risen remarkably slowly, though revenue and productivity have mushroomed in recent years.

So, do we need more scientists and engineers or don't we? Do we need more science and technology education or do we already have a surfeit of educated specialists?

The answer, I believe, is that we need to distinguish between different goals in science education. We probably have about the right number of trained professionals, though new fields such as AIDS research may need more specialists, while better understood technologies could do with fewer.

The real and persistent need for better science and technology education is at the level of our public school system. Here, the emphasis should not be solely on training youngsters who might aid the economy by becoming the next generation of scientists and engineers—though that too will continue to be important. Rather, the greatest need is for generalists who have a good grasp of how

science and technology work.

In a nation whose history has been so strongly influenced by technological know-how, remarkably few of our citizens understand the difference between problems that can be solved through scientific advances and those that can be settled only by goodwill, compromise, reconsideration of national aspirations, and changes in attitude.

The field of waste management is an example of that. Society no longer condones chemical or nuclear dumping, but for a long time we believed that we need not worry. Likewise, astonishing advances in medical technology now keep people alive years longer than was the case just decades ago, and the resulting rapid rise in the number of elderly also requires social readjustment. These are not issues we should just leave for specialists to solve for us, they are concerns for all of society.

Our greatest needs today are for our schools to prepare our citizenry to advise its legislators on how to vote on technical issues. Yet we do not pay high enough salaries to attract the best scientific talent to teach at our nation's schools. And we lack enough qualified writers who can clearly interpret complex scientific issues in school texts for youngsters and popular science writing for adults.

The nation's museums also must take responsibility. They must not hesitate to speak out on complex issues. Visited by tens of millions of citizens annually, museums staffed with well-qualified professionals should set their aim on explaining science and technology and providing insights on the role that both have played in our nation's history.

We need to be clear about where our resources for science and technology education should go. Education for specialists is reasonably well in hand. It is primarily in aiding the average citizen that we are falling short. That's where we should be setting our goals.

—Martin Harwit is the director of the National Air and Space Museum.

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## Letters

### The Side We Never Saw

In "This Old Starship" (In the Museum, April/May 1992) Ken Isbell says that the left side of the Starship *Enterprise* was never filmed and "remained unadorned." But in the 1967 *Mirror, Mirror* episode of "Star Trek," Kirk, Scotty, Bones, and Uhura, in the middle of beaming up to the *Enterprise*, are "transposed" into a parallel universe. To illustrate this phenomenon, footage showed the ship flipping left to right. At the end of the sequence, the *Enterprise* was moving right to left across the screen, with the left (port) side in view. And during the opening credits, the ship passes right to left twice. At first I thought the filmmakers had used a mirror image, but examination revealed that the decals and lights were not reversed, as would occur in a mirror.

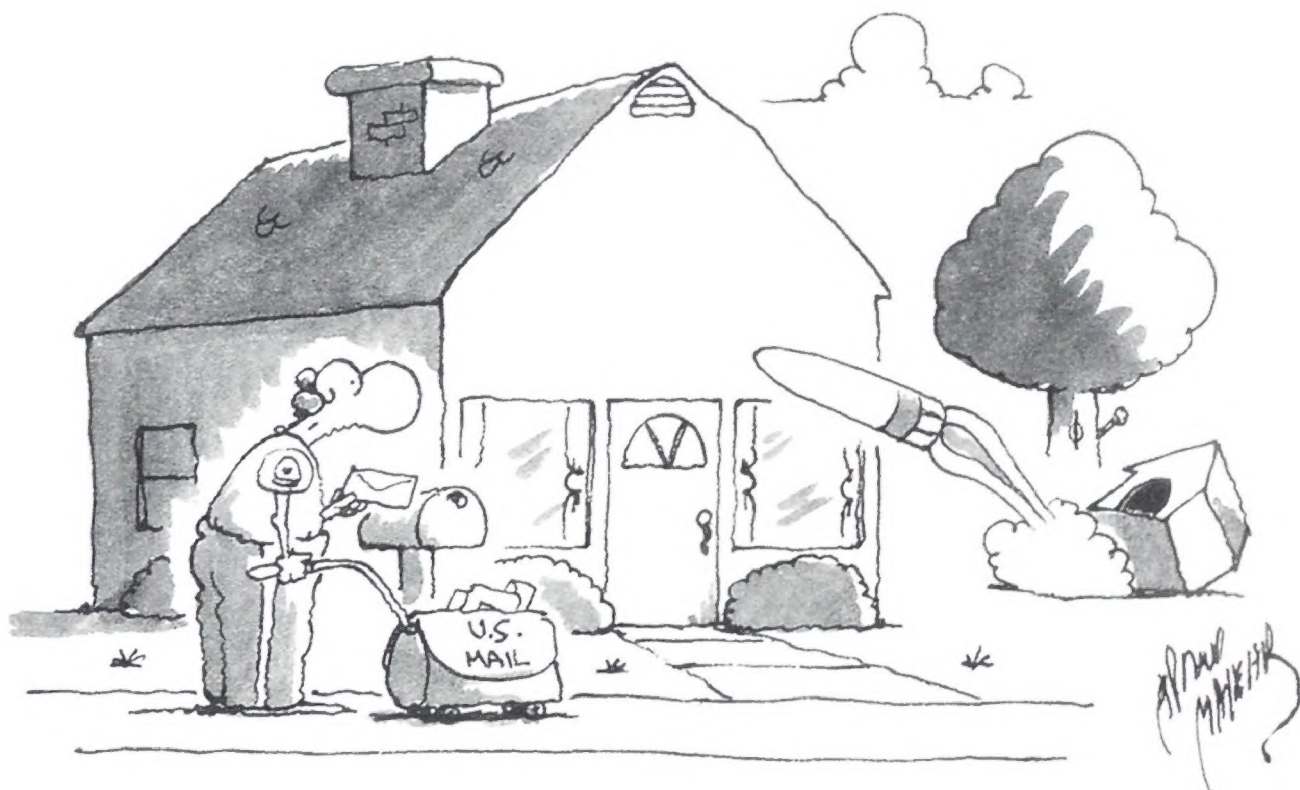
Donald S. Rudolph II  
Youngstown, Ohio

*Ken Isbell replies: The Mirror, Mirror episode has always kept fans speculating as to whether the Enterprise model was ever filmed from its left side. The confusion comes from the "flipping" effect you describe, in which the Enterprise moves in a final*

*right-to-left direction. For this footage, the right-side image of the Enterprise model was reversed to create the left-side illusion. At the same time, the model's decals were also reversed.*

### Reporting From Reno

I would like to add a few things to your coverage of the Reno air races ("The Last Piston Show," April/May 1992). The Nemesis Formula 1 team, led by Jon Sharp, Steve Ericson, Cory Bird, and me, won the 1991 Gold Race with a brand-new racer, something that's never been done in the 47-year history of this racing class. The racer itself incorporates numerous firsts in the class, including being built entirely of pressure-molded carbon fiber. It also has an onboard data acquisition system, a dry sump engine, and a four-into-one tuned exhaust. Our race speed was over 245 mph, the fastest speed in the 11 years since a major rule change and the second fastest in history. As magnificent an engineering feat as the Pond Racer is, the Nemesis was designed and built in one-third the time for a small fraction of the cost. If air racing does





indeed have a future, much of it rests with the Formula 1 class. These racers are available for less than \$30,000 and they use proven, reliable Continental 0-200 engines, which provide among the fastest speeds in any motorsport. Our success demonstrates the value of applying the latest technology. I predict our competitors will follow our example, resulting in class-wide innovation that hasn't been seen in aviation since the 1930s.

*Dan Bond*  
Nemesis Air Racing  
Austin, Texas

Larry Lowe could have explained a key reason why leaders at the first pylon usually win: extreme, dangerous turbulence behind the leader that requires followers to stay up and away and makes passing difficult. In addition, local thermals can create updrafts and downdrafts that exceed 2,000 feet per minute, and at low altitude, intense "dust devils" create violent turbulence. Some racers have even had their engines jolted loose; in 1990 one Formula 1 racer landed with its engine hanging from the safety cable.

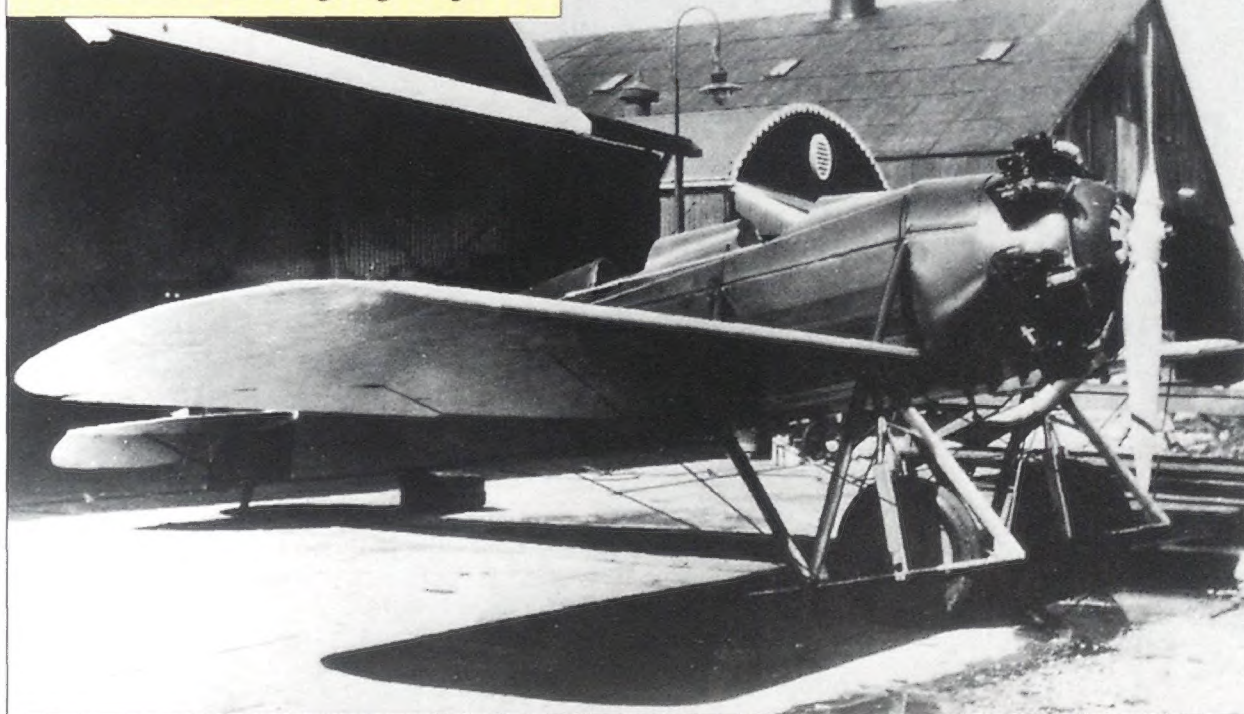
*John Joss*  
Los Altos, California

## Running Afoul

Your story about the owl eggs on Launch Complex 17-B at Cape Canaveral Air Force Station carried the unfortunate headline "NASA's Nest Egg" (Soundings, April/May 1992). For the record, the U.S. Air Force is the Department of Defense's sole manager for launch assets, and Air Force Space Command's 45th Space Wing, not NASA, owns both of the Delta launch complexes. As a contractor for the Air Force, McDonnell Douglas conducts both DOD and commercial launches from pads 17-A and -B. Range safety, telemetry, and tracking are all provided by the 45th Space Wing for NASA launches from nearby Kennedy Space Center.

As the mobilization augmentee to the commander of the 45th Space Wing, I can tell you that the Air Force and NASA are extremely sensitive to all environmental concerns. Our senior staff devote a significant amount of time to gauging the environmental impacts of our missions. Since Florida's space coast is the world's third largest nesting site for several endangered species of sea turtles, we have installed special low-level lighting to prevent them from becoming confused by too-bright lights. We are also engaged in

## Unidentified Flying Object



*Can you identify the aircraft in this photograph? From time to time the National Air and Space Museum's archives division receives photos of vehicles that its staff cannot identify. They would appreciate any help in identifying this low-wing, two-seat monoplane, which is similar to a number of early- to mid-1930s sport aircraft. The only information on the back of the photo is the penciled notation "1925," which seems much too early for this aircraft's features. If you can solve the mystery, send your response to: Air & Space/Smithsonian, Department ASP, 370 L'Enfant Promenade SW, 10th Floor, Washington, DC 20024.*

*Winfield B. Kinner of Long Beach, California, identified last issue's photo. He writes: "It was quite a surprise to flip through the pages of Air & Space and see a picture of my father under the headline 'Unidentified Flying Object.' My father, W.B. Kinner, is posing with the first airplane that he built, the K-1. He built it in 1919 in Los Angeles near the University of Southern California. The picture was taken in the farmyard near the field where he was teaching himself to fly. He is fixing the damaged landing gear. Yes, the engine was a Kemp. Dad went on to form the Kinner Airplane & Motor Company. The first airplane was damaged twice, rebuilt each time, and then sold to Amelia Earhart, who learned to fly in it. Her instructor, Nita Snook, worked at Kinner Airport on Long Beach Boulevard and Tweedy Road. Dad went on to build 26 models of airplanes."*

an ongoing beachfront project to restore the turtles' nesting habitat.

*Colonel Robert I. Recker Jr.*  
U.S. Air Force  
Orinda, California

The incident with the owl eggs is not the first time the Global Positioning System has run afoul of birds. Before moving to the Delta II rocket at Cape Canaveral, GPS payloads were launched from Vandenberg Air Force Base in California, where we had a problem at Space Launch Complex 3: birds were nesting in the top of the gantry and depositing, uh, particles on the uncovered satellite. An ornithologist climbed the tower and reported that the type of birds living there were terrified of snakes. A presumably junior employee was assigned the job of catching a snake and installing it in a clear plastic box in the rafters of the gantry.

The frightened birds flew away, thus preserving the integrity of the world's most advanced navigation system. Of course the owls probably would have considered a snake a nice lunch.

*Wayne Eleazer*  
Alexandria, Virginia

## A Policy of Prejudice

In reading Linda Shiner's excellent piece "Winging the Lecture" (In the Museum, April/May 1992), which dealt with African-American contributions to aviation history, I noted a few things that need clarifying. C. Alfred "Chief" Anderson was the first African-American to obtain a transport license. This was the highest license issued prior to 1938, when the regulations were changed with the passing of the Civil Aeronautics Act. The



new regulations established the airline transport pilot rating as the top license, and holders of the old transport license were reissued full commercial pilot licenses. Although Chief and the five or so other African-Americans who earned the transport license before 1938 were qualified to be airline pilots, racial discrimination on the part of the airlines kept any of them from being hired.

Eugene Bullard did not move to France to obtain a pilot's license. According to his biography, *The Black Swallow of Death*, he left the United States as a stowaway trying to escape the violent, prejudicial, and discriminatory treatment that was accorded African-Americans in this country in the 1890s and 1900s, especially in the South. He eventually arrived in France just as World War I began and enlisted in the French Foreign Legion as an infantryman. He fought in the trenches for two years and was wounded twice. It was while recuperating in 1916 that he requested a transfer to the French Flying Service for training as a pilot. Since the French held Bullard's heroism in high regard, they accepted him into their pilot program. Because the U.S. government did not permit African-Americans to serve in the Army Air Service, Bullard was the only African-American to serve in World War I as a pilot.

Ted Robinson  
Silver Spring, Maryland

### You Forgot the X-15

Your poster "The Pursuit of Speed" (April/May 1992) was great. But you forgot the world's two fastest aircraft. North American's X-15 flew at Mach 6.7—4,520 mph—in 1967 piloted by Major William "Pete" Knight. And Rockwell's space shuttle should also qualify for inclusion: in April 1981 John Young and Robert Crippen entered Earth's atmosphere at a speed of Mach 24.6. If you want to include manned vehicles without wings (after all, the poster listed the *Hindenburg*), the Apollo command modules entered the atmosphere at something like Mach 40. Apollo 8 logged a whopping 24,696 mph. These command modules were lifting bodies and used lift and aerodynamic control—through rotation—in their descent. Is there a reason why you left out these aeronautical achievements?

Gary H. Kitmacher  
Webster, Texas

Two very deserving aircraft missing from your foldout are the North American XB-

70, which achieved Mach 3, and the Bell X-15, which flew much higher and faster than anything shown on your poster.

Bud Lindsey  
Lawrenceburg, Tennessee

You didn't mention the magnificent XB-70 Valkyrie. Shame.

V. Windrath  
Sunnyvale, California

I thought the X-15 set the all-time speed record in the 1960s.

Michael Immel  
Renton, Washington

*Editors' reply: The aircraft featured in the poster all fell within the parameters of official absolute speed records as defined by the Fédération Aéronautique Internationale. The current record holder is the SR-71, at 2,193.17 mph. Although the craft cited above were very fast indeed, they didn't set FAI absolute speed records so they weren't included. Some of the aircraft pictured didn't set records either, but they fell within the envelope and were included as comparison points.*

### The Controversy Continues

I couldn't have been more incensed by the reaction of your readers to the Yamamoto controversy (Letters,

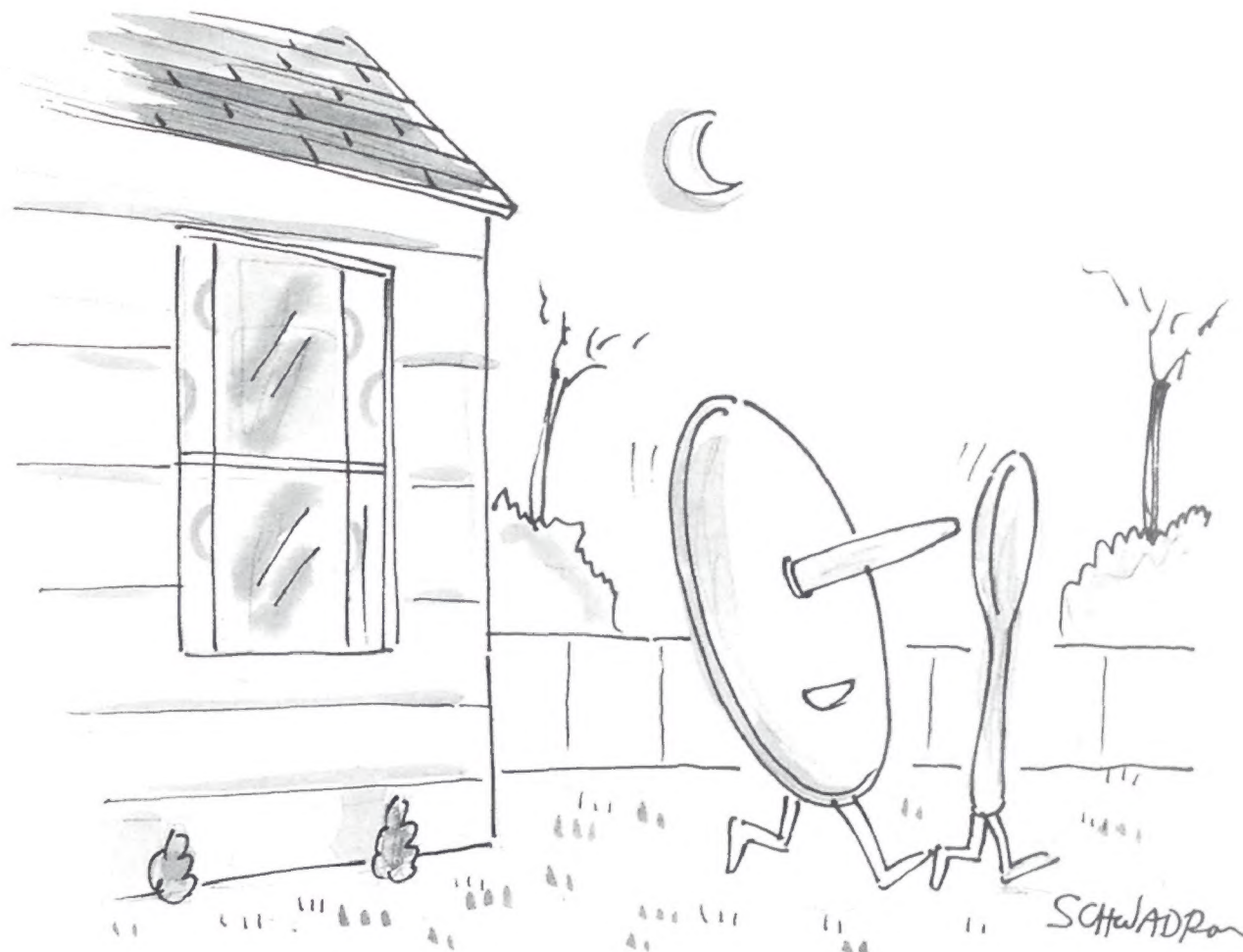
April/May 1992). The picture they painted of Rex Barber couldn't be farther from the truth. He is a gentle, soft-spoken man who didn't make an issue of credit until Tom Lanphier began publishing his unsubstantiated claims. Even then it was between him and Lanphier. As Tom Huntington showed in his article, it's mostly others who are riding herd for Barber, including the leader of the Yamamoto mission, Colonel John Mitchell.

Peter Klaput  
Marina, California

### Waiting for the Mail Bird

Reading "The Air Campaign" (April/May 1992) brought back a sweet memory. I was stationed with the 201st Infantry Regiment of what was then called the Alaskan Defense Command on Kodiak Island in early 1942. Some of the mail we received from home came by air from Seattle. How it was routed is a mystery to me, but it was delivered to Kodiak by a Ford Tri-motor, which we called "the Mail Bird." When we heard that distinctive engine sound and looked up to see the Mail Bird, our morale soared, for we knew that letters from home would be in our hands the next day.

Kent S. Freeman  
Beaverton, Oregon



*"But in the nursery rhyme, does the spoon run away with a satellite dish?"*



## An Unrealistic Simulation

While I recognize that the pararescuemen's simulated rescue mission was only a training exercise ("Rescue From Above," February/March 1992), your readers should know that the scenario was quite unrealistic. Medellin and Cali—not Bogota—are the drug cartel power centers. More importantly, the U.S. and Colombian armed forces are equal partners in the fight against narcotic traffickers, and a unilateral U.S. military operation in Colombia (which the exercise scenario suggests) is as unthinkable as a unilateral Colombian military operation would be in the United States.

Philip C. French  
U.S. Embassy  
Bogota, Colombia

## Corrections

I enjoyed Johnnie Johnson's review of *Little Friends* (Reviews & Previews, April/May 1992). The August 17, 1943 mission to Schweinfurt that Johnson recounts was my last mission with the 306th Bomb Group. Though I have always regarded this as the toughest mission to date, it is the October 1943 Schweinfurt mission that is known as "Black Thursday," not the August 17 trip.

Kermit B. Cavedo  
Richmond, Virginia

The composite photograph in "Birdmen Come to Cleveland" (April/May 1992, p. 81) actually shows three types of aircraft: fighters (top), observation airplanes (left), and Martin bombers (right). The exact models are impossible to identify with certainty.

A caption in "The Last Piston Show" (April/May 1992, p. 37) misidentified a Waco biplane as a Travel Air.

The first satellite payload to be successfully recovered in mid-air was named Discoverer, not Discovery ("...and Satellite Fishing," In the Museum, December 1991/January 1992).

We welcome comments from readers. Letters must be signed and include a daytime telephone number. Letters may be edited. Write to Air & Space/Smithsonian, 370 L'Enfant Promenade SW, 10th Floor, Washington, DC 20024. Air & Space is not responsible for the return of unsolicited photographs or other materials.

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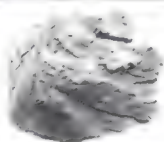
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### A Little Arm Twisting

It was undoubtedly the first time arm-wrestling had ever been covered by *Commercial Aviation Report* and *Air Transport Digest*, as well as by ABC, NBC, and CNN. But what transpired on a March morning at the Sportatorium Arena in Dallas had little to do with sport and a lot to do with the corporate style of one of the nation's most consistently profitable airlines.

The challenger was Southwest Airlines' chairman Herb Kelleher; his opponent, Kurt Herwald, chairman of South Carolina-based Stevens Aviation. The bone of contention was supposedly the question of which company had the rights to the slogan "plane smart." (Stevens, an aircraft servicing company, began using the phrase in the 1970s; Southwest coined "just plane smart" several years later.) They could have spent several years and several hundred thousand dollars in litigation, but instead they agreed to arm-wrestle it out, give some money to charity to legitimize the event, and reap as much publicity as possible in the process.

Southwest is an old pro at public relations gimmicks. In the 1970s, when it owned just a handful of airplanes and was flying out of old Love Field in Dallas, all its competitors were using the shiny new Dallas-Fort Worth airport. But entrepreneur and Southwest chairman Lamar Muse targeted one of D-FW's vulnerabilities: its bill changer gave customers only 95 cents for every buck. Southwest programmed the bill changers on its Love Field concourse to yield \$1.05 on the dollar. The nickels Southwest spent were made up many times over in publicity.

Over the years, chairman Kelleher picked up where Muse left off, building an airline that mirrored his high-spirited persona. Last St. Patrick's Day, Southwest passengers were offered free samples of Baileys Irish Cream if they could name the best airline CEO in the country (hint: his initials are H.K.).

But "Malice in Dallas," as the wrestling match was dubbed, was Kelleher's biggest stunt yet. The week prior to the



match, his team touted his training diet of Wild Turkey and cigarettes. The stands were filled with hundreds of cheering Stevens workers and Southwest flight attendants. Once in the ring, "Smokin' Herb," dressed in a T-shirt, sweat pants, and boxing trunks, retired to an easy chair in one corner. In the other, his opponent Kurt Herwald, billed as a "bodybuilder," was given a three-legged stool festooned with fake sticks of dynamite.

The match itself was anti-climactic. Herwald, 38, dispatched his 61-year-old chain-smoking opponent in seconds. To the surprise of some in the audience, each company then announced it would continue to use the "plane smart" slogan after all, leading to the conclusion that the whole event had been an exercise in publicity-mongering.

Kelleher, as he was wheeled out of the arena on a stretcher for a final photo op, summed it up best. "I don't care what you say about me," he said. "Just remember my name."

—Byron Harris

### Falling for a Falling Star

The 130-mile stretch of Kansas Turnpike that runs between Topeka and Wichita is a monotonous ribbon of pavement in a sea of wheat and bluegrass. Nothing much changes along the route, and when it does, people take notice.

Imagine the surprise of Charles Hodges, a maintenance foreman at the turnpike's Cassoday facility, when he stepped outside his office last April 7 and found a charred, twisted piece of metal in a smoldering patch of grass. The nine- by 12-inch fragment of high-grade aluminum was emblazoned with Cyrillic lettering, leading Hodges to suspect this wasn't your average tractor part.

After a highway-patrol trooper checked the object with a geiger counter, it was whisked off to the Kansas Cosmosphere and Space Center 70 miles away in Hutchinson. The Midwest may not be a hotbed of space activity, but the Cosmosphere maintains one of the country's largest collections of space artifacts (see "Space Craft," August/



September 1989) and is the biggest tourist attraction in the state.

Max Ary, the space center's executive director, was dumbfounded. "Everything about it was consistent with a piece of reentered space hardware," he says. The metal's scorched appearance and unusual hardness pointed in that direction.

And defense department satellite trackers confirmed that a spent Russian booster had indeed reentered earlier in the day over South America. Somehow, against all odds, it seemed that a fragment had skipped around in the upper atmosphere and plopped down red-hot thousands of miles away in Kansas—though it seemed strange that it could have remained hot enough to start a grass fire.

After the story made the *Wichita Eagle*, Hodges' buddies confessed that it was a practical joke run amok. They had ingeniously doctored a piece of a ruptured fuel tank into faux space debris. Hodges, something of a prankster himself, knows who did it, but he's not telling. Neither is the Turnpike Authority, which took minor disciplinary action and now considers the case closed.

The Cosmosphere staffers are a little red-faced over what Ary terms "a very sophisticated hoax," and for now their dreams of a spectacular space debris exhibit have vaporized. "We put considerable time and resources into investigating this," he says. "Maybe in a year we'll all be laughing at this episode, but right now we're not."

—J. Kelly Beatty

### Hang on to That Boarding Pass

In addition to its title as civilian test flight center of the universe, California's Mojave airport is now a mother lode for aviation memorabilia collectors.

Retired TWA captain Mike Potter is president of OK Airline Support, which stores and maintains idle transports. During his 10 years at Mojave, Potter has seen a diverse fleet come through his facility. "We never know what we'll find inside when airplanes are flown in here," he says. "I've got Convair 880s from TWA that we pulled old *Skyliner* magazines, barf bags, and Seat Occupied plaques from the seatback pockets. Back in those days we even had coffee pots embossed with the TWA globe logo. Most of those items were just thrown out—who knew people would pay money for this stuff?"

"A lot of collectors specialize in one

area or item," says Steve Griffin, an aviation photographer in Los Angeles who makes the round of collectors' shows with his portfolio. "The silverware guy can tell you what era most of his embossed flatware came from simply by the style of the spoon and the logo design on the handle, while the next table will have a collection of airline swizzle sticks. It's really quite a little industry—basically, anything with an airline's logo on it is up for grabs." At a price, that is: a mid-1930s Pan Am cup and saucer, for example, can run \$175.

Down-on-their-luck airlines have been a windfall for OK Airline Support. "Often, with the bankrupt airlines, the planes aren't really examined that well before coming out here," says Potter. "We cleaned out a number of blankets from the equipment received—really nice blue fabric with 'Pan Am' embossed along the edges, and we've pulled a number with the stitched Eastern logo."

Over the years, the airlines' cost-cutting measures have reduced the number of quality collectibles. "The Pan Am and Eastern logo blankets are

somewhat rare because a lot of airlines stopped using embroidered ones after

they found so many of them smuggled home with the departing passengers," Potter says. "More typical are the Midway planes we received. They had plenty of plain brown blankets."

And what happens to all the stuff OK cleans out of its tenants? "Well, let's just say they're stored safely away for the moment," says Potter with a grin.

—James D. Paules

### French Toast

In a birthday bash delayed a year by the Gulf war, both of Paris' international airports blew out the candles last March: Orly turned 30 and Charles de Gaulle-Roissy hit 17. Nostalgic Frenchmen

recalled the early pastoral years when sophisticated

Parisians took bus tours to Orly to ogle the former dirigible and balloon launch base.

And in the 1970s, in an age before EuroDisney, Sunday strollers took families to the burgeoning Roissy site to rub elbows with international jets.

At the Orly celebration, corridors were lined with old posters, uniforms, photos,





and press clips, while at Roissy, Air France toasted a decade at its terminal there. Nostalgia is sweet, but both airports are looking forward, not back. Passenger traffic has doubled in 10 years, and today Orly and Roissy serve over 40 million fliers. Nonetheless, each airport has memories it would rather forget.

It was a security lapse that embarrassed Orly officials. The airport's patron and France's president, General Charles de Gaulle, baptized the new terminal in February 1961. After his death in 1970, his black crepe-draped portrait was stolen from Orly's Salon d'Honneur.

Furious airport officials had to rush to the supermarket for a replacement portrait (can we buy pictures of *our* leaders at Safeway?). To this day, airport people blame the "foreign delegations" that streamed through the salon to pay their respects.

The blame for Roissy's embarrassment lies with the jet stream. On March 13, 1974, the world's air transport moguls were at the spanking new airfield to witness the arrival of the first commercial flight. TWA flight 800 from New York was due at 7:00 a.m. Unfortunately, the captain picked up a tailwind en route and the aircraft blew in an hour early. While the VIPs sipped coffee and dunked croissants, the TWA 747 hit the runway without fanfare. When word got out, guests dusted the crumbs from their lapels and

ran outside. Too late: rather than photos of Roissy's first commercial flight touching down, the auspicious occasion was documented with snapshots of flight 800 pulling into its parking slot.

—Joshua Jampol

#### Update

##### Graduates Assigned Orbits

Physician Bernard A. Harris has been named a mission specialist for shuttle flight STS-55, a cooperative mission with the German space agency scheduled for early 1993 ("The Class of 1990," April/May 1990). Three other graduates of the 1990 class have also been assigned to 1993 flights.

#### How Much Is That in Real Inches?

Millimeters and kilograms may be "the language of science and technology—and business, outside the United States," as Congressman George Brown of California recently put it, but inside—particularly inside NASA—it's still inches and pounds.

All federal agencies must convert to the

metric system of measurement by September, according to a Congressional mandate that's intended to help the United States compete with a European trade bloc forming this year. But NASA, the nation's largest science and technology agency, doesn't expect to meet the deadline.

"We are stuck," says a slightly embarrassed Joe Maloy, the leader of a "metrification" effort at Johnson Space Center, the design and development headquarters for both the shuttle and the space station—which, for the foreseeable future, will be configured in inches and pounds. "We're the only industrialized country in the world that's not on the metric system. Basically the feeling around here is, 'Let's stop talking about it and just do it.'"

The agency began quoting metric measurements in its documents in 1970 and made a half-hearted attempt to go metric after Congress enacted the Metric Conversion Act of 1975. Thirteen years later President Bush approved the Trade and Competitiveness Act, which set a September 1992 deadline for all agencies to convert. Now NASA is in a seven-year transition that began last year, when officials decreed that all new projects would be metric unless they got a waiver.

One obstacle to a wholesale switch is the scarcity of spaceworthy U.S.-built metric hardware. "Most American cars are sporting American [metric] fasteners these days, but we're not going to fly them on spacecraft," says Richard Weinstein, an engineering manager at NASA headquarters in Washington. Weinstein claims U.S. aerospace manufacturers aren't making spaceworthy metric fasteners because the industry is too stubborn to make the switch. "Some airplane companies are taking a 'Hell no!' attitude," he says. "Industry does need to get the signal that NASA is serious."

In the meantime, the primary goal of NASA's metric plan architects is avoiding confusion. "We have to be able to support both systems until the shuttle program and the space station eventually somehow evolve to the metric system," Maloy says. That means duplicate tools for every job. Most of NASA's big fabricating machines have computers that can make the translations, but myriad little items—wrenches and thermometers, for instance—will have to be replaced. Old drawings and reports won't get metric equivalents unless they have to be revised for some other reason, but new documents will come in two versions. That's because Maloy established two rules for converting to metric at Johnson.



Passengers landing at Los Angeles International Airport one day last spring may have thought they had flown into the Twilight Zone—or worse—thanks to mischievous employees at the nearby Hollywood Park racetrack. Those taken in probably felt a little sheepish when they remembered the date: April 1.

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"Number one, you don't change history. Number two, when you buy something new, make sure it can accommodate the metric."

—Beth Dickey

## Update

### A Tourist Attraction?

After being shunned by NASA, the Industrial Space Facility is on the road again—this time touring the U.S. and Canadian home-and-garden show circuit as part of an exhibit that promotes science and technology education ("Space Stations in Lobbyland," December 1988/January 1989). "Education is the sole reason we did it," says Joseph Allen, ex-astronaut and president of Space Industries International, the ISF's builder. Without NASA as an anchor tenant and with no financial support, the mini-lab's future remains in limbo.

### Maybe "Caller ID" Would Help

For 30-odd years the lingering aftershocks of Sputnik and a steady stream of tabloid headlines had the West—well, maybe just a handful of radio astronomers and UFO nuts—worried that the Soviets would score the first discovery in the search for extraterrestrial intelligence (SETI). Now the truth can be told: the Soviets never had the time, money, or cosmic contacts we thought they did.

Take it from Vladimir Strelinski, an esteemed Russian astrophysicist and the number-two man in the former Soviet Union's SETI efforts. At a Smithsonian-sponsored lecture in Washington last March, Strelinski made a persuasive case for intelligent life elsewhere but admitted that he and his colleagues haven't had the hardware to mount a serious search. "This is the biggest [radio astronomy] antenna in the Soviet Union," he said as a slide displayed a huge haystack in front of what looked like a tottering aluminum fence. Then he delivered the punchline: "This haystack reminds us that the search for extraterrestrials is like searching for a needle in a haystack." Strelinski characterized the Soviet SETI program as essentially a hobby for a small coterie of scientists who are perpetually begging for

funds and time on radio telescopes. Still, that hasn't kept them from doing some first-rate theorizing. Strelinski was part of a group that developed the Zodiac Strategy, which calls for looking out along the line of the ecliptic twice a year for signals that an advanced civilization might be beaming our way. And a colleague of Strelinski's developed the "convergent strategy of observations," the idea that SETI monitoring could be more productive if synchronized with a highly visible celestial event like a nova or other sort of cosmological exclamation point.

The first question from the audience brought the lecture down to earth with a resounding thud. A grandmotherly type wanted to know how come we're looking for aliens hundreds of light-years away when they're right here on Earth, operating UFOs out of a secret underground base in Nevada. Strelinski sighed and said, "I thought maybe this lecture would be an exception, that the first question would not be about UFOs." He went on to say that while he believed in them, having seen one himself, it was wrong to equate UFOs with extraterrestrials or even consider them as anything more than a cultural phenomenon until some genuine scientific evidence is in hand.

"UFOs are always the first question, and sometimes the middle and last ones when I speak on this subject," Strelinski later explained. "I am not opposed to this activity. But it gives people the illusion that other problems are more important than their terrestrial problems." Anyone looking for answers from the skies, he says, would do better to take up religion. He regards the search for extraterrestrials

as an intellectual exercise with no reward beyond satisfying Earthbound curiosity. Even if we someday make contact, he says, it would be a mistake to look to our new acquaintances for solutions to Earthly mysteries. Should we ever start plying them with such questions, he hopes they'll radio back: "Figure it out for yourselves."

—Frank Kuznik

### The Strong, Silent Type

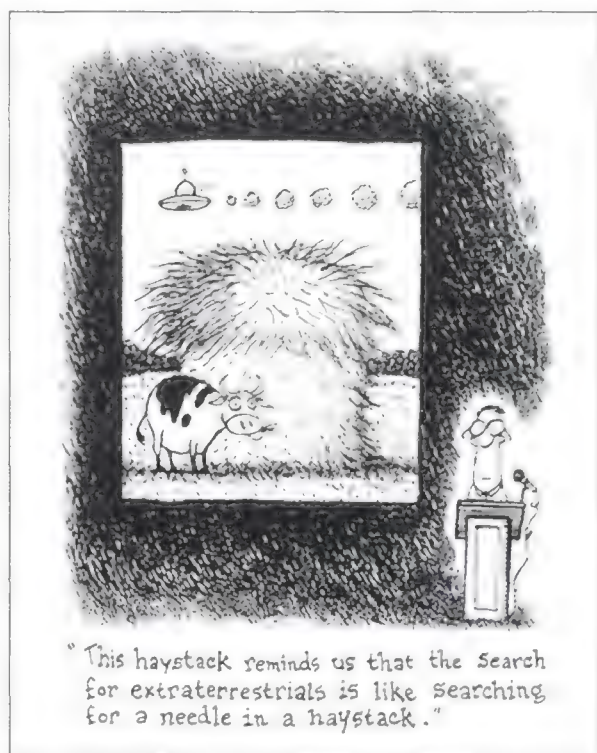
ADAM is the perfect Air Force recruit: he always volunteers, never complains, and won't require a military pension. And he revels in high-risk missions, like ejecting from a rocket sled at hundreds of miles an hour. The Air Force has a dozen ADAMs, the contrived acronym for Advanced Dynamic Anthropomorphic Manikins, to use in studying the effects of high-speed ejections.

ADAM comes in two sizes—six feet two, 217 pounds, and five feet six, 142 pounds—and is stationed at Ohio's Wright-Patterson Air Force Base and New Mexico's Holloman Air Force Base. With a fluid-filled spine, 5,000 mechanical and electrical parts, and rubbery plastic skin, ADAM, which reports on and stores four seconds' worth of data from 128 channels, has superhuman durability.

ADAM has made 34 jumps from an aging military version of a Beech 18, plummeting for 30 seconds at 100 mph before his main chute deploys. "The Air Force needs criteria for what's an allowable [parachute] opening shock," says Steve Mehaffie, a manager of crew escape technology at Wright-Patterson. "We took ADAM skydiving for a very serious scientific reason. We had so much fun with it, it looks like we did it for fun." Mehaffie calls ADAM an adept but dumb skydiver. "His landings leave a lot to be desired. He just falls on his face."

The subject under study, he says, is the human head. "If you hit an opening shock of 20 Gs, a 10-pound head now weighs 200 pounds. Your neck has to react to that. They started adding night vision goggles and radio transmitters and all kinds of stuff, so you have a 10-pound helmet on top of a 10-pound head. If you hit that with 20 Gs you're up to 400 pounds." ADAM has been making progressively faster rides in the multi-axis seat-ejection sled at the Holloman facility and is scheduled for a 700-mph run down the 10-mile track in June.

The manikin's makers would like to expand the program. "ADAM needs an Eve," says Dick White, head of research and experimental simulation at Systems



DAVID CLARK



Research Laboratories in Ohio. "Women pilots, they go fly in combat now. We need an Eve to test. That'll be the complete system."

—Bob McCafferty

### Hubble's COSTAR

When the Hubble space telescope took flight in 1990, scientists thought they were in store for an unprecedented look at the cosmos. Now the HST needs \$30.4 million in corrective eyewear. Since February 1991, Ball Aerospace Systems Group in Broomfield, Colorado, has been working on the Corrective Optics Space Telescope Axial Replacement. COSTAR, if it succeeds, will restore 80 to 95 percent of the HST's vision.

Because the outer edge of the telescope's 94-inch primary mirror had been shaped .002 millimeter too flat, only 15 percent of the light it gathers focuses at the proper point, with the remainder scattered like a halo. In December 1993, shuttle astronauts will capture the HST, remove the high-speed photometer (the instrument least in demand), and replace it with the phone booth-sized COSTAR.

After the telescope is re-deployed, engineers will extend COSTAR's 10 nickel-sized mirrors into the path of blurred light now flooding the HST's instruments. Where portions of the primary mirror are undersized, the mini-mirrors are equally oversized, which will cancel out the original error.

Once the mirrors are correctly aligned, objects now lost in the haze of unfocused light, such as faint, tightly grouped stars and quasars, will pop into view.

"Everybody is really looking forward to this," says Ray Villard of the Space Telescope Science Institute. "Right now, [the telescope] is working well enough to show us what we're missing."

—John McGauley

### Update

#### Traffic Reporter

The Federal Aviation Administration's Aircraft Situation Display, which tracks air traffic throughout the United States, will soon be made available to U.S. airlines ("Going With the Flow," February/March 1992). Airline officials predict that the radar data will increase efficiency and decrease operating costs.

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### Moved by the Spirit



Lindbergh's Spirit of St. Louis has its own powerful magnetism, enhanced by ...

A few months ago curators took the *Spirit of St. Louis* down from the ceiling for some intensive dusting and decided to leave it right in the Milestones of Flight gallery during the cleaning, rather than disappoint thousands of visitors. The little Ryan monoplane is one of the Museum's biggest draws. People linger at the second-floor railing, gazing at the *Spirit* with the reverence of Catholics filing past Michelangelo's "Pietà."

It's hard to put a finger on just what it is about the airplane and its pilot that holds both fliers and non-fliers spellbound. Aesthetically, it can't hold a candle to its gallery companions. It lacks the sex appeal of the sinister X-15. It is not as touching as the fragile Wright *Flyer*. Nor does it possess the Mach-busting swagger of the Bell X-1. When the Ryan was first rolled out of the hangar, Lindbergh, like a new father meeting his just-born child—few of whom are what you'd call gorgeous—saw "a beautiful machine... trim and slender, gleaming in its silver

coat." It is, in fact, a homely and misshapen little gray airplane that looks like it was cobbled together in someone's garage. You could say it was, considering the state of the Ryan company's San Diego facilities in 1927.

After the Museum closed one night I slipped under the rope for a closer look. Hand-stenciled on the rudder, under "Ryan NYP" (for New York-Paris), is a scripted *R* flanked by a pair of plump, hopeful wings. Elevator cables poke through the fuselage, chafing the fabric skin. I could barely make out the "Pittsburgh, Pennsylvania" in the Standard Steel Propeller logos on the blades. But the airplane is as well-preserved as Miss Havisham's wedding ensemble, so I approached the cockpit timidly, half-fearing I might find a Ryan mechanic adjusting the jury-rigged periscope or perhaps Lindbergh himself scrutinizing his charts.

I studied the claustrophobic cockpit while a vacuum cleaner roared nearby.



... Jimmy Stewart's 1957 performance.

The paper on which Lindbergh had marked off the fuel tanks he had drawn from was gone, as was his bag of sandwiches, but everything else looked as though the pilot had just been there. The charisma that the *Spirit* exudes from a distance is overpowering this close. I could imagine the panic Lindbergh felt when he realized the wings and struts and instruments were icing up, feel the inexorable pull of sleep and hear the ghostly voices that permeated that twilight state, and sense the confusion of the landing at Le Bourget.

I admit my imagination had been influenced by a viewing of the 1957 movie *The Spirit of St. Louis* the night before, which held fairly true to the book of the same title that Lindbergh had published four years earlier. Jimmy Stewart, a decorated World War II bomber pilot, had fought for the part with studio executives who considered the 49-year-old actor a bit long in the tooth to play a pilot half his age. But Stewart won out, and his



portrayal of Lindbergh, which imbued the role with more charm than the insular Minnesotan was said to have, fixed in the memory of an entire generation the romance of Lindbergh's flight.

Getting lost in the *Spirit* is a heady experience, thrilling and a little haunting. The staff hung the airplane back up near the ceiling a few weeks ago, where it will stay until it needs to be dusted again in another ten years. Maybe 100 years from then another airplane will overshadow it. But I don't think so.

—Patricia Trenner

### The Shoe Fit

"When a planetary scientist wants to investigate a planet, you need to know where you're pointing," says astrophysicist Jeff Goldstein (see In the Museum, April/May 1992) of the Museum's astrophysics lab. Goldstein should know; he's been pointing at Venus with a telescope and a set of instruments to measure wind velocities. He avoids wasting telescope time by doing his homework: determining the phase of Venus before he begins his observation. To make that research easier, Goldstein wanted a computer program that would draw the planet's phase for him given the day and the time of viewing. "I could have written it," he says, "but I never found the time." A grad student colleague had begun such a project, but by the summer of 1991 it was languishing unfinished. Enter Jenny Herbst.

Herbst had come to Maryland from



Jenny Herbst programmed a planet phaser.

### Artifacts



"Seaplane" by Charles S. Bell is one of 22 paintings by photorealists commissioned by attorney and aerospace enthusiast Stuart M. Speiser in 1973 and donated to the Museum in 1986.

California in 1989. A college dropout, she'd accumulated some credits in math, science, and physics at UCLA, but her grades, she says, were "awful." Now she wanted back into school and a shot at a degree in physics, and Goldstein, a new neighbor, offered a way: come to work at the Museum and finish the planetary program.

"Jeff said, 'Try something, so you'll be a better [degree] candidate,'" she recalls. She signed on as an unpaid volunteer and, with Goldstein's coaching, began working on a program to draw a planet's outline on a computer terminal.

"My math was really rusty, and I hadn't even touched a computer," Herbst says. She tackled the math first, attending classes at the University of Maryland to learn the complex trigonometry of oblated spheres—planets are slightly flattened at the poles—and began delving into computer languages such as Basic and Fortran. "The computer link for me was the math. The computer talked math, and that's how I learned to understand the computer," she says.

By January of this year, Herbst had come far enough to demonstrate her program to the scientists at the Museum. She is now in her third semester of calculus, and Goldstein is using transparent overlays produced by Herbst's program in his work on Venusian winds. The next step is to inject the planetary outline directly into a video monitor and perhaps to distribute the program free to interested scientists. Herbst, who sums up her progress to date

as "a Cinderella story," shed her volunteer status when she qualified for a grant program, and beginning June 8, her work will be funded by Martin Marietta.

—George C. Larson

### Museum Calendar

Except where noted, no tickets or reservations are required. To find out more, call Smithsonian Information at (202) 357-2700; TDD (202) 357-1729.

**June 3** Battle of Midway 50th Anniversary Symposium: Dean C. Allard, director of the Naval Historical Center, and pilots who flew in the battle. Langley Theater, 8 p.m.

**June 4** Film: *Midway* with Charlton Heston. Langley Theater, 8 p.m.

**June 6** Monthly Sky Lecture: "Infrared Spectroscopy of Active Galaxies." Matt Greenhouse, NASM. Einstein Planetarium, 9:30 a.m.

**June 10** Exploring Space Lecture: "Results from the Hubble Space Telescope." Edward J. Weiler, NASA program scientist, will present the latest findings. Albert Einstein Planetarium, 7:30 p.m.

### STAR TREK How to Obtain Passes:

All visitors, regardless of age, must have a pass to enter. Free same-day passes (four per person maximum) may be obtained at the Museum. Advance passes may be obtained for a fee through area Ticketmaster outlets or by calling (800) 551-7328. For recorded information, call (202) 786-2122.

### Extended Summer Hours

Beginning June 15, the National Air and Space Museum will open at 9:30 a.m. and close at 7:30 p.m. daily.





## Getting Out

Evacuations following military catastrophes have occasionally been successful, such as the one the British staged at Dunkirk in 1940, when, by fearful effort and improvisation, they managed to save most of their army from capture. The April 1975 evacuation of Saigon was not in this league.

Since the fall some five weeks earlier of Ban Me Thuot, a town of 65,000 in the central highlands, it had become obvious that the defeat of South Vietnam was imminent. The North Vietnamese army

signified that the United States lacked confidence in the South Vietnamese army—an army now obviously fleeing in terminal collapse. The U.S. embassy had put out the word that Americans could leave on the military transports that regularly flew between Saigon and the Philippines. However, neither the embassy nor the Vietnamese government would allow Americans to take out their Vietnamese families.

So the evacuation was delayed until the last moment, and then *anybody* could go.

one of the lumbering transports, usually a C-130 Hercules, would roar in, load up evacuees, run up the engines, and leave.

As a stringer for several military newspapers, I had been determined to stay until the end. But I had a Vietnamese friend named Sandy who had worked for the Americans and could have had her throat cut for it when the city fell. I decided to take her out.

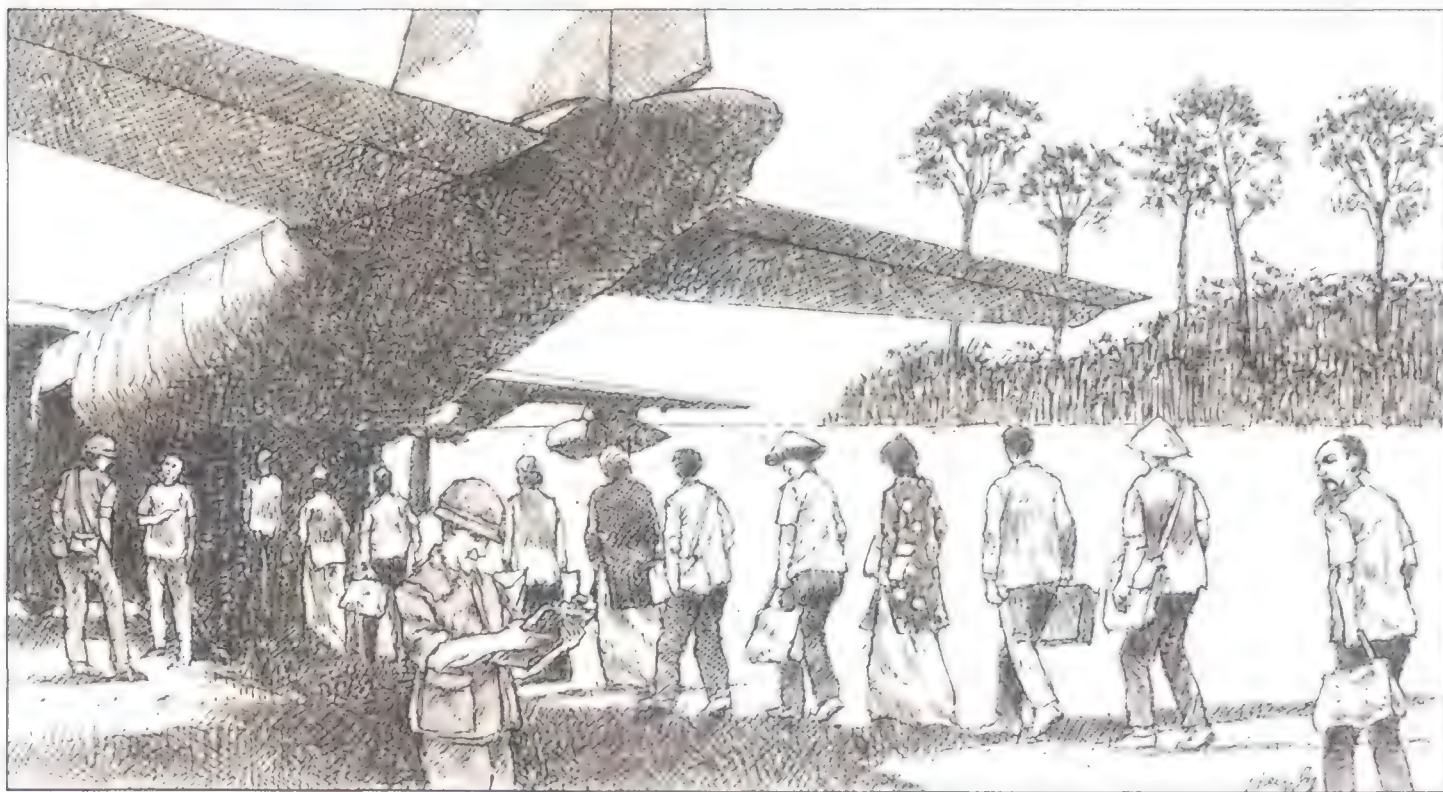
On the day we were to leave, Sandy and I went to the American Legion Post near the airport and boarded a blue bus with

anti-grenade screens on the windows. It was hot. The bus inched through mobs of scooters and decaying Citroëns to the main gate of Tan Son Nhut. A mean-looking Vietnamese military policeman boarded the bus to check credentials. He examined Sandy's papers, which alleged her to be my wife. As I held my breath, he stared hard at her, and then moved on.

The bus stopped at the tennis courts and we piled off in the ghastly heat. U.S. military police herded us into a sort of corral to begin the endless processing that would consume much of the day. F-5s screamed overhead in a futile attempt to slow the advancing North

Vietnamese army. "All right, form three lines!" shouted the MPs. "Three lines, not five lines. Get out your papers for examination. *Now.*"

The evacuation was a compromise between the practical, represented chiefly by the Air Force, and the bureaucratic, represented by the rest of the U.S. government. Policies that were impossible to carry out were transmitted from Washington, which had no idea of local conditions, to embassy employees who didn't have time to bother with them, to the military, which had to carry out the evacuation while pretending to follow the



JOHN HEINTZ

had been charging southward virtually unopposed. Yet thousands of Americans were still in Saigon—many of them contract bums, former employees of the big international contractors who had built things during the halcyon days of the war and had stayed when the GIs left, hoping that work would return. Although history has shown that the capture of an Asian city is never a good event to participate in, the state department was dragging its heels on getting the Americans out.

Politics had caused the delay. Withdrawal might have started a panic or

The result was chaos.

At 3 a.m. every morning, under the lights of the tennis courts at Tan Son Nhut, an airport and military base outside Saigon, what seemed like three-quarters of the world's population would wait in groggy exhaustion for the great hulk of a C-130 or C-141 transport to carry them from a lost cause. With artillery thumping softly in the distance, Vietnamese babies slept on their mothers' ratty suitcases. Children, too tired to care, lay on the bleachers like sacks of rice. Asian faces stared blankly, as did round-eyes, who were growing testy. Every few minutes



rules. A certain creativity blossomed to accommodate the needs of these institutions.

For example, at one point, the in-laws of American men with Vietnamese wives were allowed to fly out. Then, from afar, the rule was changed. However, if the Air Force had informed the waiting mob, about 80 percent of whom were Vietnamese, that the in-laws and their overflowing suitcases could not board the aircraft, a riot would have ensued.

Finally a fellow with a bullhorn straightened things out. "All right," he announced, "listen up! As of now, all sisters-in-law are *sisters*. Got that? All mothers-in-law are *mothers*. Change your documents."

We sat on the tennis courts in the sinking afternoon sun and waited. Helicopters *fwop-fwopped* overhead, an occasional rocket whistled in the countryside, and big things went *crump* far away. Every half-hour or so a C-130 came in, loaded up, and left. The F-5s were still racing northward in flights of three and four, although they couldn't hope to have much effect. They carried a negligible bomb load, and the North Vietnamese army had considerable anti-aircraft weaponry. A-37 Dragonflies, U.S. trainers converted for the Vietnamese air force, whined overhead, little crosses in the sky. I wondered what it was like to fly over that glowing green land in what amounted to symbolic defiance, unsure if there would be a place to land upon your return.

Despite the flow of 130s the crowd was not diminishing. More people poured in behind us. The hot air began to smell of stale sweat and not enough diapers.

Night fell, soft and cool. People sprawled on the green cement. In the distance but moving closer, artillery made its pillowy *whoomphs*. Occasionally a rocket sizzled in the city. Mortar flares trembled on the horizon, trailing thick white smoke under their parachutes.

Still the 130s came and went—ugly, inelegant, but indestructible. Rumor had it that Lockheed had started with a design for a dump truck and kept modifying it until it flew. A 130 will land hard on short dirt strips, scrubbing off speed with the impact, and take off from sites a civilized airplane wouldn't dream of. Most of all, it is stolid and untemperamental.

Finally, well past midnight, it was our turn. The 130s were coming down steeply now—the rocket men with their heat-seeking missiles might be close enough to take a shot. We heard a Hercules land, furiously reverse the props, and taxi up to the embarkation point, its ramp dropping

slowly like an enormous jaw.

We staggered through the darkness, fighting a wind that reeked of burned kerosene. The crew had elected to keep the engines running. Loose articles sailed into the night. Sandy and I were surrounded by slender girls in *ao dais* that whipped in the blast, dazed-looking children, grandmothers in black carrying wicker baskets that held all they had left in the world.

There were no seats in the roaring cavern of the fuselage, and no lights, which could attract ground fire. Thick nylon cargo straps ran across the floor. Men, women, and kids squatted on metal flooring with gaping expansion joints. A crewman in earphones trailing a wire that kept him in touch with the rest of the crew yelled over the din, "Keep the kids' fingers outta the cracks or they'll lose 'em!" A young airman stood guard on the ramp holding an M-16; I wondered if he knew how to fire it.

Very quickly the fuselage was full; the ramp was closed and the pilot taxied to the runway. Airplanes were arriving more frequently now, and a lot of rules and regulations were being flat-out ignored. We reached the runway, turned sharply, and got a rolling start on a takeoff.

The Hercules set off like a scalded cat, turbines howling, skin rattling, the whole airplane squealing and hissing. This was not your gentle peacetime takeoff roll. The pilot wanted to be somewhere else pronto and had communicated his desire to the four large turboprops.

We climbed at an astonishing angle, clawing for altitude in a tight corkscrew, trying to stay over friendly territory—now shrinking rapidly—until we were above the range of the surface-to-air missiles. I wondered how many people could fit in a C-130. Enough, I figured, to get the pilot court-martialed at any other time.

The last I saw of Saigon was the lights of the city slowly revolving in the side door, through which poured a terrific wind. The engines roared, and terrified kids clung to their mothers. Below us, people waiting for the next 130 were piled on the tennis courts in the red blackout lights like bodies in a mass grave.

I hoped that if we took a missile hit it would just take out one of the engines and not the wing spar. But no missile came, and soon we were cruising calmly over the South China Sea on the way to the Philippines. As we had pulled away from Saigon, I thought fleetingly that I was witnessing the end of an era. Then I could only think about how tired I was, and how badly I wanted to sleep.

—Fred Reed

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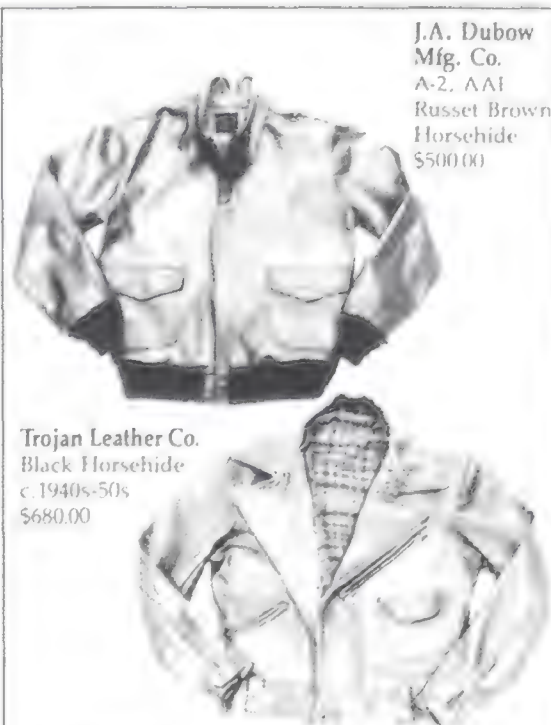
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## Out of Shape

You wouldn't know it to look at me today, but as a young teen I wanted to be an aeronautical engineer when I grew up. This desire lasted about three months, but what a noble aspiration it was, particularly in light of the fact that I had no idea what an aeronautical engineer did. But I liked the "aer," which I've always felt conveyed an exhilarating sort of streamlined swiftness.

Looking back, I can see how irresponsible and silly it all was, selecting a career on the basis of how neat its name was. What if everyone did that? No one would want to be an actuary and everyone would want to be a sexagenarian. Ultimately, thank goodness, I rejected a career in aircraft design. But I have retained a fondness for airplanes and rockets. I like their shapes. Indeed, if someday I succumb to romantic impulse and abandon my family, quit my profession, and run off to Tahiti to be an aeronautical engineer, of the many items I will no doubt forget to bring along (a T-square, enough sunblock, basic competence), a design philosophy will not be one of them. I have a ton of design philosophy, all of which can be conveniently boiled down into two axiomatic principles. When it comes to man-made flying devices,

(A) the pointier the better, because

(B) non-pointy aircraft are scary.

Yes, scary. Dirigibles, blimps, old-fashioned balloon-shaped balloons, newfangled hourglass-shaped balloons—to me, they're all, well, frightening.

I know they're beautiful. I know they're ecologically correct. I know that, in contrast to every other form of air travel, the stately pace of a balloon literally allows you to stop and smell the roses, or at least drop sandbags on them. Still, there is something universally disturbing about globes and cigar-shaped shapes drifting noiselessly through the sky.

I suppose I'm just not used to seeing

rounded forms up in the firmament. (Of course there's the sun and the moon, but they're family.) It's tempting to probe for, or simply make up, Freudian explanations for the thrill of unease these aircraft evoke in me—e.g., balloons suggest the maternal breast; a blimp is really a menacingly large phallus. But I don't buy it. It's not the primal familiarity of these objects that gives me the willies, but the opposite: their alien quality.

Up in the air, in that infinite-seeming space which is as thin and insubstantial as the Earth is dense and

intractable, I expect to see sticks and crosses: airplanes, rockets, birds, hang gliders, Superman, and so forth—shapes that recapitulate *my* shape, since every airplane and bird consists of a body-and-wings that I feel to be congruent with my torso-and-arms.

But the big, dumb Goodyear blimp poking placidly along gives me a special version of the creeps. There's something off-putting about its *armlessness*, just as there is something similarly upsetting about the torsolessness of the old flying wing, or, for that matter, its sexier, smart-aleck offspring, the B-2. If we need a radar-proof bomber, can't we just paint a B-52 matte black, install a Fuzzbuster, and

leave it at that?

Does it have to look like a cross between a Corvette and a Batarang?

Or—and here may be the secret of the ickiness of these craft—like a manta ray? Maybe that's what these things resemble most: marine life, in shapes either familiar (like a blimp) or exotic (a gussied-up balloon). Which makes the explanation not Freudian but Jungian. Noiseless, drifting, oddly shaped, perhaps their appearance in the ocean of atmosphere summons up ancient fears evoking archetypal confrontations we can only dimly specify. A rocket is a spear, an airplane is a bird. But a balloon floats in silence like a denizen of the sea, a symbol of the collective unconscious and primeval repository of weirdness itself.

And so does an airship, except it has a propeller. So it's a fish with a motor. If that isn't creepy, what is?

—Ellis Weiner



STEPHAN HICKMAN



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# Happiness Is a Hot Jet

*For upwardly mobile civilians, surplus military fighters and trainers are the ultimate toys.*

by Stephan Wilkinson

*Photographs by Chad Slattery*

Looking for the Soviet MiG franchise in the United States? Head to Burlington, Vermont, and ask for Dean Martin. "MiGs are my specialty," says Martin, who acquires much of his stock from the surplus-fighter parking lots of the Hungarian Air Force. "I know 'em all, from the MiG-15 to the -29, like the back of my hand. Yeah, I admire them. They're made to operate out in the field—probably the most operable aircraft in the world.... I've got my dibs in now for a two-seat MiG-23," a big swing-wing fighter that looks somewhat like a General Dynamics FB-111A. "I don't know why—it's a very expensive aircraft to operate," he says. "Big ol' maintenance pig, a lot of systems—but I want one."

The bluff, beefy Martin—a man who hides his shyness under a cloak of brusqueness—was one of the earliest players in a game that has attracted considerable interest from wealthy American sport pilots: buying and flying ex-military jets, ranging from distinguished Korea-era fighters to odd-ball Third World trainers recognizable only to those who consider *Jane's All the World's Aircraft* fun reading.

"I can probably get a decent MiG-15 or -17 out of China for \$65,000," muses jet-fighter broker and rebuilder Bruce Goessling. "It'll cost you a total of \$80,000 to \$125,000 by the time I get it here and flyable." Outside his dusty, cluttered airport office in Chino, California, it looks like the South Vietnamese Air Force—Skyraiders, Caribous, Buffalos—plus

Grumman S2Fs and other utilitarian types—has come to park and eventually disintegrate in the 103-degree desert sun. Behind Goessling's scorched hangar, old Folland Gnat fuselages are piled like aluminum logs. A battered MiG-17 awaits restoration in the hangar while two mechanics rebuild a P-51 that landed in a rocky riverbed after the engine failed.

"The French are ready to deal too," Goessling confides. "They're interested in selling surplus Mirage IIIs. And



*For California businessman and jet fleet owner Chuck Thornton, time—and money—flies at Mach 1-plus (left). Members of the Classic Jet Aircraft Association, who met for the group's first convention in 1989 (above), prefer the real thing over models any day.*





### Dollars and Sense

Much of the rise in the popularity of civilian-owned military jets is due to the fact that while far slower World War II fighters have become museum pieces, selling for \$500,000 and up, most cast-off jets run the gamut from worthless to curiosities. Only some fought in wars, few made history, and none are yet collectible.

So what's the bottom line? Though the value of totally restored jets can run anywhere from \$450,000 (Morey Darznieks' Folland Gnat) to \$1.6 million (Chuck Thornton's Northrop T-38s), the pig-in-a-poke lesser machines are often priced lower than today's twin-engine Cessnas and Pipers. From a recent issue of *Trade-A-Plane*, the aviation version of *Pennysaver*.

•CASA 200	\$65,000
•Lockheed T-33	\$75,000
•MiG-21PF	\$75,000
•Lockheed F-104G	\$85,000
•Republic F-84G	\$94,000
•de Havilland Venom	\$100,000
•Douglas A-4B Skyhawk	\$110,000
•Folland Gnat	\$130,000
•Fouga Magister	\$165,000
•Canadair F-86	\$275,000

"Runs good, needs work"... "Disassembled but flyable"... "85 percent restored"... "Good project plane"... Read the fine print.



*Manual labor: it takes a well-read operations manager like Jim Tyner to keep a Northrop T-38 in top condition (left).*

*Chuck Thornton (right) turned a hobby into a business and now restores, brokers, and maintains ex-military aircraft ranging from P-51s to F-5s. Thornton's fleet earns its keep in films. One of his T-38s once donned Los Angeles Police Department livery for Dragnet '87 (above).*

"I've got some nice Aero L-39 Albatrosses available—very overlooked airplane," he says, pulling a folder from a drawer and displaying a photo of a Czech two-seat jet trainer that looks a little like a straight-wing version of an A-4 Skyhawk.

Though thrilling to fly, surplus military jets aren't all fun and games. In recent years a number have crashed, killing their pilots and raising questions about the wisdom of joyriding in supersonic fighters. The surplus-jet owners aren't helped by their position at the very bottom of the aeronautical hierarchy. They cannot claim to be standing ready to rush serum to Nome or to be bringing business to communities abandoned by the airlines, as does general aviation. They cannot claim to be training the cadre of a future airline, as can the tiniest flight school, or to be vital links in the





national transportation network, as even the grottiest air charter operator will.

"The public isn't going to find this an endearing group," says Ron Myres, manager of the Federal Aviation Administration general aviation regulatory branch. "They're loud, they're noisy, and they're rich. So how much compassion will people have for them? We do, though, from the aviation viewpoint. We think it's important to have all different kinds of aircraft utilizing the airspace."

The FAA is primarily concerned with the safety of non-pilots—people on the ground who don't want airplanes falling on their heads, as well as people in the air who entrust their lives to pilots. If a surplus-jet owner insists on making a smoking hole in a desert floor, aviation regulators may be dismayed and even saddened, but they will not be embarrassed. If a Texas playboy drops his turbine toy into a schoolyard or shopping mall, however, the government may be goaded to such regulatory extremes as banning the amateur



operation of civilian-owned military jets.

"What our country is all about is enjoying the fruits of our society," says Classic Jet Aircraft Association president Chuck Parnall. "You have to have all these challenges available, whether it's the challenge of riding a motorcycle or flying a jet. Also, the more we take our aircraft to airshows, the more that people realize there's a whole lost generation of aircraft that came between the World War II piston-engine airplanes and the modern military jets."

If Dean Martin is "just a Vermont farm-boy," as he ingenuously suggests, Chuck Thornton is the epitome of the California pilot-cum-businessman. He arrives for an appointment at his Los Angeles hangar in a pinstripe suit, glistening black wingtips, and impeccably conservative maroon-striped shirt and tie. In his office he places his enormous Rolex, a billet of gold, on the sterile desk between us, where it serves to remind me that Time Is Money, that I am deal-





*Delta Airlines pilot Paul Entrekin (above) runs a business on the side flying his MiG-15 at airshows (right). The MiG-15 was one of the first Soviet jets to turn up in the civilian market. Today MiG-21s are advertised in Trade-A-Plane.*

ing with A Busy Man. The son of Litton Industries founder Tex Thornton, he comes by the affectations honestly.

Downstairs, in a hangar so clean the floor literally squeaks, sits Thornton's private air force: a supersonic Northrop F-5 fighter, two equally speedy T-38s (the two-seat trainer version of the F-5), and a pudgy, knock-kneed Italian SIAI-Marchetti S-211 trainer that is virtually brand-new. Bought by the Haitian Air Force as one of a fleet of four, it flew a mere 100 hours before a palace coup made it possible for Thornton to snap it up.

Like any canny entrepreneur, Thornton has turned his hobby into a business, realizing that the only way to finance a personal air force is to put the airplanes to work in government and industry projects that require the capability of ex-military aircraft—movies, for example. If you've seen *Hot Shots*—the forthrightly juvenile spoof of *Top Gun*—you've seen Thornton's Northrops and S-211. The Thornton Aircraft Company also maintains its customers' aircraft and does complete restorations of used jets.

Morey Darznicks of Dallas hasn't the faintest interest in putting his Folland Gnat to work. His pampered little jet, once a Royal Air Force advanced trainer and later a Rolls-Royce company chase plane, today flies purely for pleasure. Offered \$30,000 to loan it to the makers of *Hot Shots* for three weeks, Darznicks declined, in part because two Gnats involved in the filming had crashed. But perhaps more to the point, the 49-year-old non-pilot owns the Gnat simply for the joy of watching the earth roll upside down and the Texas clouds slide around the sleek canopy while a Delta Airlines pilot, who serves as his Gnat chauffeur, flies aerobatics. "The thrill is just unbelievable when you get into a high-performance jet," says Darznicks, who is also the world's largest supplier of salvaged parts for the World War II T-6 trainer. "You don't have to be a pilot to enjoy it. I don't fly for a living, so I see no reason to learn. I just enjoy sitting in the back seat and having someone who's a professional up front."









## Hot Seats?

Should the ejection seats in civilian-owned military jets be "hot"—usable? Pilots argue pro and con, and even the Federal Aviation Administration isn't sure. "That's under discussion with our engineering personnel who are developing standards for [the maintenance of] ejection seats and drop tanks," says FAA safety inspector John Thiem.

External fuel tanks must be jettisonable on some aircraft, such as the F-104, which can be rendered unbalanced by an uneven fuel load. But a pilot can easily drop the tanks into an unpopulated area. "I think everybody feels uncomfortable about somebody exiting an

aircraft during a takeoff or landing," says Thiem. "Maybe we should say: 'The ejection seat can be operable, but only if you're going to use it over the Gulf of Mexico.'"

"In an F-86 at 25,000 feet, when the engine quits that aircraft is going to go wherever it wants to go," says Super Pinto owner Mike Dillon. "When you lose power you lose flight controls, and there's no reason you should go with it. The public doesn't know that stuff falls out of the sky all the time—pieces of airliner cowlings, ice buildup from their lavatory outlets, stuff from space. But the vast majority of this country is unpopulated. You can randomly drop things from space and they won't hit

cars, people, houses, or anything."

"I don't know but one or two accidents where a hot seat would have saved anybody," says Folland Gnat owner Morey Darznies. "If one person survives but risks sacrificing 50 on the ground, I can't understand that. It's my thrill, so I should be taking the risk, not the people below me." The ejection seats in his Gnat are disarmed.

"The military put ejection seats in there for a reason: because these aircraft have low survivability if you have to land gear-up or have a structural failure," says jet broker Chuck Thornton. "Would I use one if I had to punch out on takeoff? You bet. I want to live too."

For Darznies, Thornton, Martin, and dozens of other audacious aircraft enthusiasts, that excitement—the thrill of owning and flying airplanes that were never meant to fall into civilian hands—is unbeatable. Some own entire fleets: a 34-year-old Houston oilman, James Robinson, has nine flyable jet fighters, ranging from an archaic British Vampire, a cartoonishly ovoid twin-boom design with a wooden fuselage, to an F-104 and a MiG-21, each capable of Mach 2. Others own a single treasured jet: Paul Entrekin, a young ex-Marine helicopter pilot who flies for Delta, indulged in "some creative financing" to buy a 1950s MiG-15 and now runs a part-time business flying it at airshows.

Trainers, which are relatively economical to operate, are popular entry-level purchases. Dean Martin was one of the first to market such a craft, and he has sold some 30 Fouga Magisters, a small, V-tail French trainer once flown by the Patrouille de France, the French Air Force demonstration team. Powered by a tiny engine of piercing sibilance, the airplane has earned the nickname Dogwhistle. "It's an airplane you don't mind selling to somebody," Martin says, "because if they have any sense at all they aren't going to hurt themselves in it."

Another popular trainer is the Spanish CASA Saeta 200 jet, though it is reviled by purists. "The CASA looks like a catfish from the front," says David Strait, a Dallas resident who flies a handsome Douglas A-4B Skyhawk that saw considerable service in Vietnam. "Normally, people who get into this business look at the dollar numbers and first buy a Fouga, a CASA, or an old two-seat Vampire. They're always sorry they did after a while, but those funny-looking little airplanes are good entry-level trainers."

"But the trainers are like Italian wines," says Lewis Shaw, a Dallas real estate investor. "They aren't sexy." Shaw flies a decidedly unsexy Yugoslav SOKO Galeb G2 trainer. "I have a friend who says, 'If I can't get it in and out of the hangar myself, it's not worth owning.' That's one of the reasons I'm flying the Galeb and not a P-51 Mustang. Those old piston warbirds require a support system. These European trainer jets are perfect for sport pilots."

Trainer or fighter, tell your neighbor you're thinking of



*Chuck Parnall, president of the Classic Jet Aircraft Association, flies a Vampire in addition to a desk.*





*Flying surplus jets isn't all fun and games. Dave Zeuschel was killed when his F-86 flamed out, lost hydraulic power, and crashed on a California runway in 1987.*

buying one and he'll no doubt ask, "Isn't that illegal?" He'd almost be right, for the Department of Defense never intended for used-up tactical aircraft—airplanes that carry guns, bombs, or rockets—to become available to civilians. Michael Dillon, a Scottsdale, Arizona ordnance expert, and military-jet owner, has insights probably as good as anyone else's into how the hobby started. Dillon is a lanky, balding, low-hipped Westerner who spent 14 years as a TWA copilot before forsaking airline boredom for entrepreneurship. His company, Dillon Precision Products, makes ammunition-reloading equipment and videos for sport shooters, and his hangar holds a Hughes 500 helicopter, three impeccable Beechcraft T-34 piston-engine trainers, and a rare Super Pin-to jet prototype.

"When Castro took over Cuba," he explains, "it became embarrassing that a lot of ex-U.S. military airplanes ended up in Cuban hands [after the Bay of Pigs fiasco]." So the government ruled that no tactical aircraft would be decommis-

sioned until it had first been "de-milled"—de-militarized. "Which meant mutilated," Dillon explains. "They had to cut through the wing spar, torch the landing gear attach points, and destroy primary structure until the aircraft was no longer rebuildable."

The first jets to become available to civilians were Royal Canadian Air Force T-33s and F-86s, built under license by Canadair and eventually sold to civilians in the mid-1960s. "The Canadians adopted a similar law," Dillon says, "but they straightforwardly called it the Mutilation Law. Only they eventually figured out they could make a hell of a lot more money selling the airplanes than [mutilating] them and rescinded the law." Other countries—Norway, Israel, Egypt, Sweden, Great Britain, China, Australia, and Dean Martin's prolific Hungary—who either had purchased U.S. or Soviet jets or had manufactured their own fighters reached the same conclusion.

Some enthusiasts tried to find other loopholes by snapping up surplus U.S. jets that had been donated to trade schools and municipal playgrounds or to other countries through reciprocal deals. But that proved an expensive quagmire: if taxpayers had originally paid for the airplane, it was forever off limits. One California T-33 owner reportedly spent





over \$50,000 restoring his junkyard jet, only to learn that it could not be licensed because the government had never given up the title.

Others assembled flyable jets from scrap parts bought on the open market. Air racer Darryl Greenamyer painstakingly built an F-104 using a prototype airframe intended solely for ground display and testing—no one had thought to “de-mil” such a mule—and Chuck Thornton found his first T-38 hidden in a barn in Sonoma, California. The trainer had been badly damaged in a gear-up landing and sold to a scrap dealer. At the time the Air Force was up to its epaulets in scrap-worthy airplanes being shipped back from Vietnam, and someone carelessly let the trainer slip through without being de-milled.

The Sacramento ice cream parlor. In the history of civilian-owned military-jet disasters, it ranks right up there with the *Titantic*, *Hindenburg*, and Little Big Horn. In 1972, after an airshow on a hot day outside the California capital, an F-86 Sabre, one of the first high-performance surplus jet fighters to fall into civilian hands, ran off the end of a 5,000-foot runway still scratching for lift, barely aloft in the cushion of air created by ground effect. The airplane was creating more drag than it had power to overcome, and the pilot's only options were to put the nose down and crash or pull the nose up and crash.

The Sabre took out an ice cream parlor, killing 22 patrons. (The pilot was slightly injured.) The outcry was immediate.

*Morey Darznieks rides in the passenger's seat of his Folland Gnat while a Delta pilot chauffeurs him around the Texas skies (above).*

*A Super Pinto prototype (right) is the jewel of Mike Dillon's collection, which comprises T-34 piston-engine trainers and a helicopter.*

Few non-pilots had any idea that amateurs were flying jet fighters. The Federal Aviation Administration, deeply embarrassed, considered banning all operation of ex-military jets by nonprofessionals. The Departments of State and Defense were none too pleased either. They had never intended surplus fighters to be used for sport, and those that were beginning to appear at airshows had apparently flown into the United States through legal loopholes. (The Sacramento Sabre, for example, had originally belonged to the Royal Canadian Air Force.) “At the time, there really was no additional training or FAA approval required to operate those types of aircraft,” says John Thiem, an FAA safety inspector who specializes in surplus-jet operation and regulation.

“It was kind of surprising to us when [the flying of surplus jets] started,” says the FAA's Ron Myres. “The state department was concerned about it. The FAA's perspective was that we understand it's a rich boy's toy and all that, but we do support it because we believe they can be operated safely if enough limitations are put on them. We think we can





limit the risks enough to make it worthwhile for these things to be operated if people can afford them."

Regulations were stiffened after Sacramento, and much that had been informal was formalized: how surplus jets were maintained, who could fly them, how and at what altitudes they could be flown at airshows, what sort of training was required, even whether they were allowed to fly supersonically. (Though going supersonic over the United States is generally prohibited, that regulation doesn't cover offshore waters or certain military preserves to which civilian-owned jets might have access.)

Still, the safety of surplus jets has remained a sore point. At a Society of Experimental Test Pilots presentation in Washington, D.C., early in 1989, Dean Martin proved distressingly casual. Addressing an audience of by-the-numbers pilots, he boasted that his usual method of assessing prospective pilots was to "take a guy up, turn him inverted in the [airport traffic] pattern...and see how he does." When a perplexed questioner asked if he had a procedures manual, Martin answered: "Nah. You just gotta give yourself some room, then go for it." (Martin may have proved distressingly casual in other business dealings as well: last December he was arrested for possession of stolen property—\$200,000 worth of avionics—but charges were dropped.)

The more conservative operators decry the procedures and proficiency of the more casual fliers. "They killed eight guys last year and I think six [in 1991] already," says Thornton. Goessling estimates there are only 50-odd active civilian-owned jet fighters in the country, a number that would make stunning the accident rate Thornton quotes. Chuck Parnall of the Classic Jet Aircraft Association, guesses the active number may be closer to 100, while A-4 pilot David Strait, who says he has done a "marketing survey," puts the number at 280.

Some recent accidents, each of them typical in that surplus-jet crashes often are caused by backyard maintenance and modifications, low-altitude aerobatics, and lack of pilot proficiency:

- A Canadair CT-33 (the two-seat version of the P-80) owner and his passenger were killed when the airplane crashed and burned, apparently suffering catastrophic wing failure that began with the wing tanks, which had been modified by the owner.
- An F-86 crashed at Shafter airport in California, killing its pilot, when an engine flameout shut down the hydraulically activated flight controls. When the pilot attempted to land with the gear up, the airplane bounced in the runway several times, rolled over, and burst into flames.
- A Folland Gnat, en route to a *Hot Shots* filming site, crashed in Louisiana, killing the two pilots aboard. The airplane had run out of fuel in bad weather as a result of navigation problems created by loss of electrical power. The airplane was making its first cross-country flight after the owner had extensively modified the electrical system.
- Another Gnat crashed during a low-level roll for a *Hot Shots* cameraman, killing the pilot, and an A-4 Skyhawk cartwheeled and disintegrated after hitting the ground during a low pass for a commercial, also killing the pilot.
- A Cessna T-37 collided with a piston-engine A-26 bomber





while flying formation, losing its tail to an A-26 propeller. The two people aboard the T-37 died when it crashed.

- A de Havilland Venom, on its third takeoff attempt, failed to take off from a 7,000-foot runway because its pilot tried to lift off prematurely, much like what happened in Sacramento. He could neither climb out of ground effect nor, by the time he realized his error, land and stop. The pilot died in the ensuing fire.

- A Fouga Magister stalled and crashed at the Experimental Aircraft Association fly-in at Oshkosh, Wisconsin. The pilot had turned too steeply and slowly onto the final approach to the runway—a classic low-time pilot's accident. Both occupants were uninjured.

Knowledgeable surplus-jet pilots attribute most accidents to poor maintenance and plain old risk-taking. "Issues that are irrelevant at 250 knots, which is a pretty fast World War



II warbird, become critical at 400 knots," Chuck Thornton explains. Thornton also points out that a pilot may be able to buy a jet for \$100,000 but unable to afford the tens of thousands a year it takes to maintain it properly. Thornton Aircraft has an enormous library of F-5 and T-38 manuals and engineering drawings—20-foot rows of binders containing every scrap of paper ever published on the maintenance, rebuilding, modification, and updating of the Northrop jets. "This is what the guy who buys an old de Havilland Vampire typically has," says Thornton, pulling two binders down from a shelf.

About a third of Thornton Aircraft's revenue comes from movies and commercials. "We've done maybe two dozen commercials

and four movies," he says—enough to have given him insight into the sirens that lurk in the shoals of aviation films. "In a military environment maneuvers are practiced, re-prac-





*Air National Guard F-16s escort Dean Martin's MiG-21 over Vermont just for the fun of it (above). Martin (left), a MiG collector, gets most of his stock through contacts in the Hungarian air force.*

*Ray Mabrey's Canadair T-33 Silver Star wears the elaborate paint scheme of the U.S. Air Force Thunderbirds (right).*

ticed, and analyzed, but on a set you're dealing with people who don't know anything about airplanes and are asking you to do things in an environment that is unique. People who don't have formation flying and military experience tend to get in trouble."

Since the days of *Wings*, *Hell's Angels*, and *Flying Leathernecks*, pilots have literally died to be on camera. Even the great stunt pilot Paul Mantz was killed making one more pass for the cameras filming *The Flight of the Phoenix* in 1965. Yet surplus military jets are inevitably in demand when the casting call goes out for another low-budget war movie, and if the number of Gulf war films approaches that of Vietnam movies, only immense forbearance will save some starstruck jet owners.

"The main problem with a jet is that it's very, very easy to fly—easier than a [single piston engine] Cessna 182—but it requires far more judgment," says Galeb owner Lewis Shaw.

"Military aircraft were designed for the military environment, flying from one low-traffic military base to another. It never entered the mind of the designer that the pilot might be playing around in the [airport traffic] pattern with Pipers.

"In a military jet, you're always pushing your fuel. The other day I was returning with my typical end-of-flight fuel margin—maybe half an hour—and as I tuned in the tower, I heard [the controller] say, '...and do you need any assistance?' I was already in a turn toward an alternate [airport] before he even reached the end of the sentence. Turned out it was a student pilot with a blown tire and the runway was clear, but that's how you have to operate a jet."

And that, mind you, is Shaw's docile trainer. "In a jet fighter, you're essentially out of gas when you take off," says Dean Martin. "When you land you're *really* out of gas. In a MiG-21 it's even worse. When you get somewhere you have to land right *now*. You've got to have your act together and so does everybody around you. When I fly the 21s out of Burlington, I first get on the phone to the tower and to [air route traffic control] center, tell them we're going to be launching in half an hour, be back in no more than 45 minutes, we're going to be 300 knots in the pattern, go three miles out on downwind, can't do 360s [to accommodate other traffic], can't be jerked around, and when we're ready to land we gotta land."

On the walls of the stairway leading to Chuck Thornton's office hang testimonies to the challenge of flying surplus fighters: portraits of two jets that later crashed. A third such photo is about to be hung. "Those guys were all friends of mine, and someday that wall's going to be full," Thornton muses. "It's something I can walk past every day and remind myself that I'm not the world's greatest pilot." ✈





Just ten years ago, only a handful of satellite navigation specialists had ever heard of the Global Positioning System. An obscure Department of Defense program, it had all the earmarks of becoming another collection of overpriced, oversold space hardware.

Today GPS is absolutely the hottest thing in orbit, the techno-star of the Gulf war and the object of a multibillion-dollar tug of war between the military and private industry. Moreover, the uses for GPS are multiplying so rapidly that it may well live up to its advance billing as the next universal utility, a service that will one day be as ubiquitous and indispensable as the telephone.

At first glance, GPS seems more mundane than revolutionary. It's a 24-satellite array (only 18 are currently in place) that does a deceptively simple thing—tells you where you are. It can tell you in two dimensions (longitude and latitude) or three (altitude), and if you're moving, it can tell you how fast.

If you were ever a Boy or Girl Scout, chances are you're already familiar with the basic principle behind GPS, that of calculating position by triangulation. On the ground, that's done by taking compass bearings to several known points and drawing lines of position that intersect at your location. When the known points are satellites in space, the process is more akin to taking sextant sightings of celestial bodies—with several important refinements.

Instead of measuring the vertical angle to the satellite, a GPS receiver measures the amount of time it takes a radio signal to reach it from the satellite. To do this, both the receiver and the satellite generate continuous, identical digital codes synchronized in time down to the nanosecond. By comparing the signal code it's receiving to the one it's generating, the receiver can easily calculate how long it took the signal to travel from the satellite and, based on that information, the satellite's distance.

Once the receiver gets position information from three satellites, it's a simple matter to triangulate its precise location. GPS receivers routinely take readings from a fourth satellite to eliminate an extra intersection of points (in three dimensions, triangulation from three satellites actually produces two

# You Are HERE



GPS satellites  
can tell you where you  
are—within inches.  
So why do  
civilian users think  
the military is telling  
them to get lost?

by Frank Kuznik



SCOTT ANDREWS

possible points of intersection) and to offset any potential clock error—an important consideration when a discrepancy of even 0.001 second can throw off distance measurements as much as 1,860 miles.

What makes GPS a quantum leap forward in navigation is its astonishing accuracy and access. With the right equipment, you can use GPS to pinpoint your location within inches. And because GPS satellites are circling 10,900 miles above the planet, they're impervious to the weather conditions and gaps in coverage that plague ground-based navigation systems like Loran-C, which rely on pulsed radio signals sent out by a network of ground stations.

The impact of such a system extends well beyond navigation—though making all air and marine travel safer would be no small accomplishment—into a vast array of commercial applications. Oil drillers, surveyors, resource managers, urban planners, geophysicists, and a long list of other professionals already rely on the system, as do the U.S. Coast Guard and Forest Service. The uses for GPS multiply literally by the week. GPS is either under study or in testing for such diverse uses as vehicle tracking, traffic management, and geographic information systems. Some Japanese auto manufacturers already offer an in-dash GPS receiver as an option on luxury models.

In short, life is about to change dramatically for everyone who needs help getting where he or she is going, from a solitary motorist negotiating the streets of an unfamiliar city to a sea captain steering a giant oil tanker through Prince William Sound.

Or so it seems. The catch to all this is that the U.S. Department of Defense paid for the system, so it gets to make the rules—one of which is that only the military gets the most precise position information from GPS. Last July, the

*The Global Positioning System relies on Navstar satellites like the one at right, which are launched by Air Force Delta II rockets (left). By next year, the system's 24 satellites will form a constellation that can provide precise navigation and timing data for every point on earth.*



*Electronics are replacing optics in traditional surveying as GPS makes it possible to measure precise distances with satellites.*

military added a "dither" to degrade the civilian GPS signal, so everyone else has to live with inaccuracies of up to a hundred yards, or buy lots of expensive equipment to clean up the signal. Not surprisingly, commercial users and manufacturers are in an uproar. It's an odd posture for an industry reaping the benefits of a \$10 billion investment by the military, though not nearly as odd as the Pentagon's unusual willingness to explain itself.

"I don't necessarily ask [commercial users] to be grateful, but I would at least ask them to attribute some conscientious motives to the defense department in the way we employ the system, and not to think that we're being callous or arbitrary," says Air Force lieutenant colonel Jules McNeff, the Pentagon's point man on the GPS program.

Does McNeff have any thoughts on why the civil GPS community so mis-



COWELL/KIRKLAND INTERNATIONAL

interprets the military's actions and motives? He mulls the question over silently in his cramped, windowless office, then finally replies, "None that are appropriate for publication in a widely read magazine."

The Global Positioning System has its roots in two other military satellite navigation systems, a Navy program known as Timation and an Air Force program called 621B. Timation was fur-

ther along in development when the two were combined in the early 1970s, but both envisioned using a satellite network to provide a continuous three-dimensional global positioning service. From a military standpoint, a comprehensive navigation system was overdue—and financially attractive.

"The one thing that occurred again and again in Vietnam was that the lack of a common coordinate frame made air-to-ground coordination very difficult," says Stanford University aeronautics and astronautics professor Brad Parkinson, who as an Air Force colonel oversaw the development of GPS from 1972 to 1978. "The major reason I was allowed to proceed, though, was because the military did a survey and found that there were something like 103 navigation systems, which were enormously expensive to support. They realized that this system could obviate the need for about 90 percent of them."

Parkinson likes to brag that his team closeted itself over a Labor Day weekend and married the best elements of the Navy and Air Force systems into what is now GPS, but in fact much of



WATSON/US NAVY PHOTOGRAPHY



that work had already been done in 1971 and 1972 by a joint military steering group that was the forerunner of Parkinson's. "We went through a year and a half of comparisons, deciding what the specifics of the system should be—how many satellites, at what altitude, signal codes, modulation techniques, things like that—and what they would cost," says Keith McDonald, then-executive director of the steering group and currently president of Sat Tech Systems, a private consulting and R&D firm. "We came out of that with the system pretty well configured."

What made GPS possible was the development of atomic clocks that generate continuous, identical digital codes in near-perfect synchrony. The most precise method of timekeeping yet invented, atomic clocks rely on the oscillations of cesium, rubidium, or hydrogen atoms to keep time. It wasn't until 1977, however, that atomic clocks were considered durable enough to be launched into orbit. The following year the military launched the first of 10 "Block I" GPS satellites, prototypes of the Block II satellites now being launched to complete the final configuration of 21 satellites plus three spares.

The Block I satellites, designed primarily to test the feasibility and mechanics of the system, turned out to be so good that four are still operating. But they weren't equipped with features to

prevent civilian users from exploiting the system. Military planners had anticipated some civilian interest in the system, so they designed it to generate two signals—a precise one for the military called the P code, and a second with discrepancies of 50 to 100 feet, called the C/A (coarse acquisition) code.

The C/A code is easy to receive, but also easy to jam. The P code requires a more sophisticated receiver and knowledge of certain code keys. Two protective features were also designed into the system. One is known as anti-spoofing, which is an encryption that makes it impossible for an enemy to broadcast a counterfeit P code. The other, more controversial feature, is the aforementioned signal dither, better known as selective availability. By adding false information to the C/A signal, military operators degrade its accuracy to within a hundred yards. That, in their judgment, is precise enough for general civilian use yet wide enough of the mark to prevent hostile nations or terrorists from using GPS to drop a bomb at someone's back door.

"Selective availability is in place to protect against those people who want to exploit GPS for hostile military purposes, either against us or against each other," explains McNeff. "Full GPS accuracy is an enormously useful military force enhancement tool. It doesn't take

COURTESY TRIMBLE NAVIGATION, LTD. (3)



*Charles Trimble entered the GPS business when he bought a test model receiver from his employer for \$130,000.*



*Navigation systems are already being installed in the dashboards of some Japanese cars.*

## Help From Above

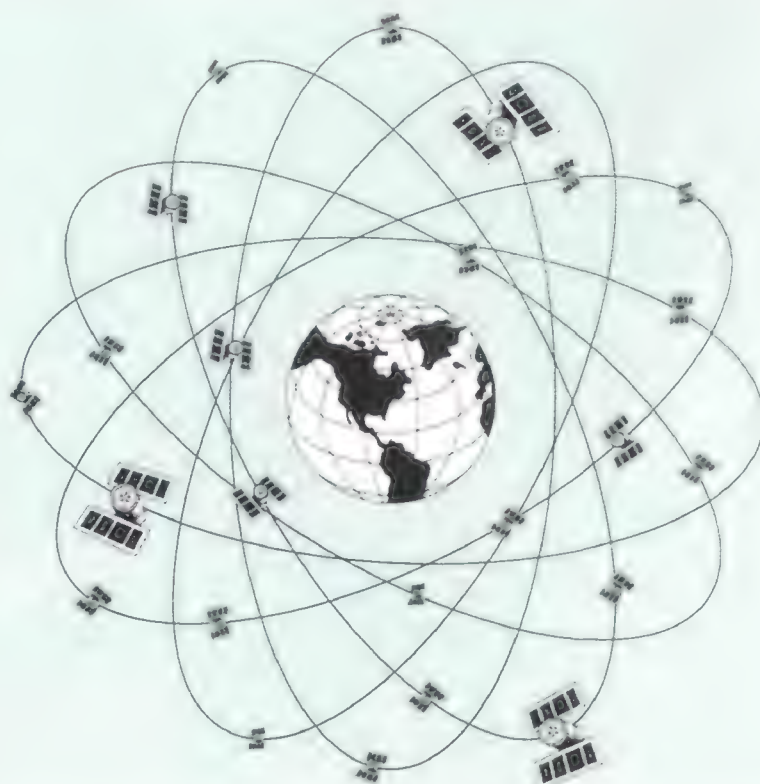
Circling at an altitude of 10,900 miles, a network of 24 satellites in six orbital paths will guarantee that there are always at least four satellites above the horizon for every point on earth. The satellites and the ground-bound GPS receivers both generate a continuous, identical code, which allows the receiver to calculate how long it takes the signal to travel from the satellite, and then to extrapolate the satellite's distance. Once the receiver gets position information from three satellites, it's a simple matter to calculate its position by triangulation.

### How does GPS work?

- *Triangulate from satellites*
- *Gives position, altitude, velocity and exact time*



*Manufactured by Rockwell International, the GPS NAVSTAR satellites weigh almost a ton and have a lifespan of 7.5 years.*





a rocket scientist to figure out that if a military capability is dropped in the world's lap, there are a good number of people who will exploit it for non-peaceful purposes, and it won't take them very long to do it."

All of which, in theory, seems straightforward and reasonable enough. In practice, it hasn't quite worked out that way.

Compared with the private sector, the government—particularly the defense department and its cumbersome procurement procedures—moves at a snail's pace. But even by those standards, the speed with which the commercial exploitation of GPS has outstripped the military's methodical development and implementation of the system has been astonishing.

Selective availability didn't become possible until the Block II satellites were lofted into orbit, starting in 1989. By then, commercial entrepreneurs had taken the unrestricted GPS signal and run with it like jackrabbits.

One of the first to gamble on the system's potential was an electrical engineer named Charles Trimble. He was working at Hewlett-Packard in 1982 when he was offered the opportunity to buy the company's test model GPS receiver. The military market for receivers was already locked up by big companies like Magnavox and Rockwell Collins; Trimble's genius was in seeing what he calls "a series of niche opportunities" in the commercial market that he could exploit while the system was still in development.

The first opportunity Trimble identified was time transfer, a complicated procedure for disseminating precise time information between distant locations. The market is mostly limited to scientific institutions, electric utilities, and communications systems. In the past, time transfer required actually flying an atomic clock to whatever distant location required precise time. But the four atomic clocks aboard each Block II satellite now make it possible to use GPS to synchronize clocks from ground stations.

Trimble next saw an opportunity for using GPS receivers to help offshore oil companies position drilling rigs in a featureless sea. Major manufacturers like Motorola and Texas Instruments



*Engineers are using GPS to provide measurements for a survey that will determine the ability of San Francisco's Golden Gate Bridge to withstand earthquakes.*

had already opened up that market, but Trimble simply undercut them. In 1986 Texas Instruments had a GPS receiver priced at \$100,000-plus; Trimble could offer the same technology for \$46,000.

Today he is president and CEO of Trimble Navigation, which last year grossed nearly \$151 million.

"What Trimble did was let other people create the educational awareness, then come in behind them riding the wave, selling equipment at a much lower cost," says Stephen Colwell, former director of market development at Trimble Navigation and currently president of Colwell-Kirtland International, a GPS marketing and consulting firm. That's





MAGELLAN SYSTEMS

*Their ability to pinpoint a position in a featureless sea has made GPS receivers a valuable tool for ocean exploration.*

typical of the rest of the GPS market. Because new companies have driven down prices, receivers have become more affordable and the market has grown.

What had initially appeared likely to stunt that market was not future re-

strictions on the signal but a fee that the military planned to charge civilian users. Impractical at best, that idea was shot down in 1983 along with Korean Airlines flight 007, which was blown out of Soviet airspace after drifting nearly 400 miles off course—a deadly mistake that might not have happened had the commercial airliner been equipped with GPS. (If the KAL crew had programmed their navigation computer incorrectly, though, even GPS would not



AVIATION WEEK & SPACE TECHNOLOGY

*The French air force installed GPS receivers in its Aerospatiale Puma helicopters (above), which made it possible to recover a U.S. pilot who had ejected from his F-16 during the Gulf war. GPS receivers played a key role in the war by providing precise position information to troops in desert terrain (right).*

have saved them.) President Reagan responded by declaring that GPS would be made available free of charge to the world community.

"All economics were in question as long as there might be an arbitrary charge for the use of the signal," says Trimble. "Once that was put to rest, commercial usage of the system really blossomed."

If anything should have held the commercial market in check, it was the limited coverage available as the system was being put in place—two, three, four hours a day at most. But even that small window offered users some opportunities. "If there had not been an economic use for four hours a day of satellite coverage, we frankly would not have survived," says Trimble. "However, after the offshore oil industry collapsed in the winter of '85, we devoted our entire attention to figuring out how to use this four-hour window to make money for private surveyors."

Coverage was limited to six hours when the first Block II satellite went up in early 1989, but by then GPS's potential was so clear that startup companies such as Magellan Systems could feel confident raising \$5.8 million in venture capital and selling \$3,000 receivers to boat owners. "I didn't think there was a tremendous risk that the government would back out of a \$10 billion program to build the next gen-





J. LANGVIN/STGMA

eration of navigation infrastructure," says Magellan president and CEO Randy Hoffman. "The big risk was: How fast was the coverage going to grow? And would it be fast enough to enable us to grow before we ran out of money?"

Hoffman needn't have worried. Coverage grew to virtually 24 hours over the next year and a half, and the fortunes of companies like Magellan and Trimble grew with it. Charles Trimble has announced that his next goal is to crack the Fortune 500.

Ironically, the commercial GPS market's biggest boost came from the military, courtesy of the Gulf war. Desert Storm provided a virtual showcase for the military uses of GPS, which guided troops across vast stretches of featureless desert and enabled bombers and artillery units to shell the enemy with devastating precision.

"If you had contrived the best possible war to show GPS's abilities, you would have done Desert Storm," notes Brad Parkinson. "Obscured visibility, no landmarks, an electronic war in which knowledge was of immense value—it was perfect."

Desert Storm was the military's first real test of the system, yet the Pentagon was so unprepared it had to buy most of the GPS receivers used in the Persian Gulf from Trimble Navigation and Magellan Systems. Trimble and Magellan became emergency suppliers, selling the Pentagon 10,000 and 3,000 receivers respectively. Along with a sales windfall, the companies got the kind of

publicity money can't buy. "Magellan was mentioned on network news three separate times during Desert Storm and on local TV stations in the Los Angeles metro area a number of times," says Hoffman. "Clearly, exposure like that has an impact."

While GPS turned out to be a star performer under combat conditions, the Pentagon inadvertently set the stage for a furor by turning off the signal dither during the war, just a few months after enough Block II satellites were in place to finally turn it on. There was no choice; U.S. troops were equipped with commercial receivers, not P code receivers. They needed a clear C/A signal. But civilian users had the benefit of that signal as well, and now that it's been degraded they're crying foul.

"During Desert Storm the system was so magnificent that many of our users became used to it and have that level of expectation," says Gary Burrell, president of Garmin International, which makes receivers for the marine and aviation markets. "I think it's a great disappointment to the world community that this magnificent tool has to be degraded."

But even that is only a temporary stumbling block. Commercial users have developed a refinement called differential GPS to overcome the degradation. Normally, commercial GPS receivers are accurate to within 10 to 100 yards, depending on atmospheric conditions, orbital drift, and whether or not the military is adding the dither. Each

of these problems can be corrected by differential GPS, which involves putting a receiver at a precisely plotted location and comparing the reading on that receiver to its actual location. The difference, known as the error correction factor, can then be subtracted from the readings of nearby GPS receivers.

Differential GPS has made it possible for precise work to be done over large areas without the benefit of sight lines and in almost any kind of weather. "Suddenly you were seeing engineering firms that were able to go in and survey 400 square miles of wilderness," says Stephen Colwell. "Where before it would take them two and a half years, now they could do it in a period of three and a half weeks."

That surprised even the system's creators. "When we were developing the system, we had not planned on the applications that the surveyors came up with," admits Keith McDonald. "They've been very clever at developing software and coming up with ways to use the system and get around the degraded signal." At the moment, differential GPS is used mostly by surveyors, seismologists, and other professionals who need precise measurements and can afford the equipment.

Some commercial users contend that by turning on selective availability, the military is actually encouraging the development of differential GPS and other methods for circumventing it. "To a limited extent you probably do," responds Jules McNeff, "but in large part





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you really don't. Those users who want to get the most out of the system, like surveyors working on the centimeter level, are going to require differential or other techniques to improve the accuracy of the signal whether we have selective availability on or not. So selective availability isn't really the driver in terms of putting in place those very-high-precision kinds of systems. And you trade that off against making a militarily useful signal directly available to the rest of the world. Is that something we feel comfortable doing? Up to now, the answer has been no."

The military may be forced to reconsider when large differential systems start springing up to serve the thousands of cars that will be equipped with GPS receivers by the end of the decade. Already, differential systems are being built in Europe for marine navigation, a development that hasn't escaped the Pentagon's attention. "We've cautioned our international partners that when you put in place differential systems, you're making available a militarily useful level of accuracy that can be exploited by anyone," McNeff says.

Its stubbornness over selective availability aside, the military has shown a surprising willingness to accommodate commercial manufacturers, most no-



COURTESY TRIMBLE NAVIGATION, LTD

*The 1990 Oakland hills fire (top) was plotted by a GPS receiver aboard a California Highway Patrol helicopter that flew along the perimeter of the firestorm. The plot was laid over a map (above) and sent to firefighters so they could track the blaze.*

tably in talks last year regarding export controls. After lengthy discussions with members of the U.S. GPS Industry Council, the Department of Defense (along with State and Commerce) actually liberalized export controls on GPS receivers. Key restrictions are still in place—no receivers suitable for use in military aircraft or missiles can be exported, for example—but otherwise the Pentagon was remarkably receptive to the argument that to keep the lead in GPS technology, U.S. firms need to

compete overseas. According to Scott Pace, deputy director of the Office of Space Commerce at the Department of Commerce, the argument wasn't hard to make. "Look, it was because we had an innovative, robust GPS industry that we had the commercial receiver sets that saved everybody's neck in Desert Storm," he says. "So the question was: Are you going to run harder and stay ahead, or are you going to try to be controlling and fall behind?"

Industry representatives, for their part, say they are working to cooperate on national security issues. "In our talks with the defense department we tried to understand and to be responsive to their national security concerns," says Anne Ciganer, director of government relations for Trimble. "Having American kids on the battlefield during Desert Storm really took that out of the abstract and brought it home."

The question now isn't so much whether the signal restrictions are fair as whether they're superfluous. While the Pentagon has been preoccupied with launching and fine-tuning the GPS system, a \$500 million-a-year industry has grown up around it with plenty of ideas for circumventing dither on the signal. Already there's loose talk in the corridors of the Pentagon about the aggravation and expense of maintaining the system, and predictions that it will probably be turned over to civilian control one day.

And why not? By 1996, the domestic GPS market alone is expected to exceed \$6 billion a year, with the military accounting for less than 20 percent of the total. Some 65 companies have jumped on the GPS bandwagon, and a reported three-quarters percent of the world's countries are already engaged in GPS mapping projects. Every day the commercial GPS juggernaut seems to grow bigger.

In short, GPS may still be the military's toy, but there's no way to keep everyone else from playing with it. "There's no question that the military would love to put a higher fence around this technology," says Charles Trimble. "But the market for GPS boards to go into cars in Japan is already on the order of 10,000 a month. So there's no way to draw a fence around it. And the military knows it." —



# The Beach House

In a little  
Florida cottage,  
astronauts  
experience some  
of the most  
emotional  
moments of their  
lives.

by Mike Mullane

*Photographs by Scott Andrews*



*"Nothing else could be so perfect for an astronaut's contemplations—a star-fired sky, an occasional satellite transiting the twilight, a xenon-spotlit shuttle to the north."*

1978, shortly after I was selected to serve as a mission specialist in the first group of shuttle astronauts. We were given tours of all the NASA facilities, and the Beach House was part of our Kennedy Space Center visit. I think all of us were immediately struck by the strangeness of the sight: situated less

From the outside, it looks like any of the thousands of low-rent retreats that line Florida's beaches—a boxy little house with a small deck and a crushed-shell driveway. Even before entering you know it will have a flotsam art decor, torn screen door, weak flushing toilets, and bugs. Lots of bugs. To look at the house you'd never guess that it was part of NASA's manned spaceflight operations. But as a veteran of three shuttle missions, I can tell you that this modest structure, referred to simply as the Beach House, plays an essential role in every astronaut's life.

Built back in the 1950s, the Beach House was one of more than a hundred residential properties NASA acquired while expanding its Cape Canaveral launch facilities in the days of the moon race. With an urgency reminiscent of the Manhattan Project, NASA even netted a couple of motels in this exercise of eminent domain. Some of these properties were outfitted as temporary offices for the expanding ranks of NASA employees. Others were gutted and then reinforced with load-bearing posts so they could be used as warehouses.

Eventually, though, new construction caught up with the demand for floor space, and these old, inefficient properties were abandoned. One by one, they were either sold or burned down in firefighter training exercises, until all that remained was a single beach house. In a decision that proved exceptionally farsighted, NASA saved that lone structure from the torch to serve as a retreat for the press-hounded early astronauts.

I first visited the Beach House in

than a mile in front of a goliathan Air Force Titan launch pad and about three miles south of shuttle launch complex 39A was a small, plain two-story house.

The first floor consists of a garage and storage area, while the second floor includes a den, two bedrooms, and a deck. The den has a long table and an easel-mounted blackboard, and it is used by NASA managers as a place to brainstorm America's assault on the heavens. Because the Beach House is isolated, yet close to the Kennedy Space Center, it provides a perfect, cost-effective sanctuary for uninterrupted thought and discussions. It has also been employed for purposes far removed from the space program: once a University of Florida research team used it to store equipment for studying the Atlantic tides.

For the astronauts, however, the Beach House has a different function. To fully understand it, you first have to understand the pressures the crew members experience in the days before a launch. The training schedule, for one, is brutal. Like modern-day Jonahs, astronauts virtually live in the bellies of simulators as they rehearse procedures until every conceivable mission scenario is mastered. In the late stages of preparation, it is not uncommon to put in 60 hours a week training. And the resulting exhaustion is frequently aggravated by the need to shift sleep cycles drastically. In the week prior to launch the crew will sleep and work according to the mission clock. Often a launch is scheduled to take advantage of such transitory circumstances as the position of Earth or of a satellite. If the launch time is 2 a.m., that will mandate



a sleep period of 1 p.m. to 9 p.m. And this in turn may mean simulator training sessions that run from midnight to noon.

Being separated from one's family is another burden. To reduce the possibility that a crew will carry an infectious disease into orbit, NASA quarantines its astronauts. At L minus seven days (seven days prior to launch), they leave their homes and families and take up residence in a motel-like facility at the Johnson Space Center in Houston. From then on, only spouses and those personnel who are essential to training are permitted any contact with the astronauts, and all must first pass a physical exam. If a wife has a cold, she will have to kiss her husband through a surgical mask—a new twist in safe sex. Because kids are at a higher risk for infectious diseases, no one under the age of 18, including the astronaut's children, may visit. This isolation continues after the astronauts move to Kennedy Space Center three days before launch. There, they stay at Crew Quarters, basically a small dormitory, while families, who have traveled to Florida separately, are housed in condos in nearby Cocoa Beach.

If isolation, a grueling work schedule, and a circadian leap across 10 or 12 time zones were all that burdened an astronaut in the weeks preceding a launch, the job would be not unlike that

of a doctor or nurse or airline pilot. However, there is a stress that is unique to spaceflight—preparation for tragedy. Before a launch, astronauts and their families update wills, review insurance policies, and study NASA family contingency plans, which spell out what the agency will do for families in the event of an accident.

And, by NASA directive, they select Family Escorts. For each mission, two fellow astronauts are picked to help care for the families after the crew enters quarantine. But escorts also stand ready to play another role. In the event of a mission disaster, their title changes to Casualty Assistance Officers, and they become responsible for helping the families in the darkest of hours.

The selection of Family Escorts is a shining example of the ability of the human spirit to steel itself against the specter of loss. Usually the spouses do the choosing, most often at some social function, perhaps over dessert at a crew party. They make their selections carefully, but with never any mention of the second, grim duty that escorts might have to assume. In the three selections I have witnessed, no one would have ever guessed from the women's discussions that they were picking potential escorts into widowhood.

By the time crew members arrive at the Kennedy Space Center, they have smiles on their faces and bags under their eyes, and their souls are in the grip of both gut fear and overwhelming joy. Where do they go to relax, to privately confront those emotions?

The Beach House.

Some find relaxation in jogging, and the sand in front of the house has been pounded by the feet of generations of astronauts—the heroes of the Mercury program, the moonwalkers, and the anonymous masses of the shuttle era. Countless others have gone to the Beach House simply for its isolation. They might shove a couple of bills in the cash box of the Crew Quarters' refrigerator and take a few beers with them. Or they may grab a tape player to listen to music, or bring religious reading material. But it has been an escape to themselves that all have sought. Sitting out on the deck, they quietly reflect on the magnitude of what they are about to do—fly an eight-and-a-half-minute con-



trolled explosion into space.

In some of my evening reveries there, I had the impression I had stumbled upon a movie set designed by an overzealous special effects artist. It seemed nothing real could be quite so beautiful or more appropriate for an astronaut's contemplations—a star-fired sky, an occasional satellite transiting the deep side of the twilight, a xenon-spotlit shuttle to the north. The latter sight would invariably bring my heart to my throat—three miles away a spaceship was being readied for me!

On some evenings the sights would be too strong a magnet and I would stay the night, using chair cushions to form a bed on the rough wood of the deck. Sleep would be difficult and sometimes I would bolt awake, heart pounding in fear, only to look toward the shuttle pad and be immediately overwhelmed with







joyful anticipation. Fear and joy are an astronaut's constant companions.

The Beach House has also seen its share of tears. I suspect many astronauts sought its isolation to deal with their grief after the fatal Apollo 1 fire and the *Challenger* explosion. On my first post-*Challenger* visit to the Cape, I sought its sanctuary. There is probably no place an astronaut can feel closer to a lost comrade than on a walk along the Beach House sand.

Spouses also know the Beach House. Approximately 24 hours prior to launch, the Prime Crew (the crew of the imminent mission) hosts a meal there; depending upon launch time, this could be anything from an early morning breakfast to a midnight barbeque. The 20 or so guests include the astronauts' spouses, as well as key NASA personnel who have been laboring to get the

mission ready. The get-together is a way for the crew to thank these workers for their efforts, but the main purpose is to allow the astronauts to say goodbye to their spouses. Usually it will be the last time before the mission that the couples will spend together.

The protocol is for the other guests



to stay about an hour. Then hands are shaken, best wishes given, and thank yous delivered, and those guests depart. Single astronauts frequently leave as well, though they are free to remain, and any friends that have come to see them off are, like spouses, permitted to stay.

The goodbye that husbands and wives face at the Beach House is one that most could never have anticipated when they were standing at the altar. Hand-holding couples scatter. Some walk north or south and disappear around the distant bends in the shoreline. Others stay close, spreading a blanket just beyond the dune walkover. Still others wait until they are alone in the house. But no matter how they seek isolation, they all struggle with that mix of fear and excitement, now at a crescendo.

Some probably bare their souls in silence, conveying messages with nothing but body language—a squeeze of the hand, an embrace, a kiss. I recall the moments my wife and I shared before my last mission as poignantly reflective. For us, it would be the end of a chapter in our lives, and we marveled at the twists of fate—military service and war and schools—that had brought us to this goodbye. Others may try to joke or laugh their way around the reality of what is about to separate them. At least a few couples have dealt with their emotions in the most intimate of ways (one wife jokingly complained that there were no sheets for the Beach House's convertible sofa). Whatever the case, I would bet many crew members voiced a similar sentiment: "If anything happens, remember, it was a dream come true for me."

Probably because doing so raises the possibility of failure, NASA does not emphasize the basic human drama that crews and their spouses live in the final weeks of a launch countdown. Actually, the agency has no business doing that. The astronauts hold the copyright on their emotions, and it's their call to share those feelings. But that is rarely done. We hide behind a Right Stuff facade, finding it very difficult to admit to each other, much less to outsiders, the emotions that overwhelm us as the calendar turns toward Launch Day. But ask the Beach House. It has seen our souls. —









# I Was a Teenage Astronaut

by Linda Shiner

For the kids at Space Camp, this is as real as it gets.

*Photographs by  
Richard Nowitz*

A small specialized team at the U.S. Space and Rocket Center in Huntsville, Alabama, is busy with a project that captures the essence of space exploration: braving the unknown, preparing for the unpredictable, and laying the groundwork for communication with the alien. For eight days at a time, these people house, instruct, and chaperon groups of 50 to 100 human teenagers.

The U.S. Space and Rocket Center is a NASA visitor center, a space theme park, and home of U.S. Space Camp. Space Camp is

really several camps in one: a five-day "introduction to space sciences and exploration" for little kids (grades 4 through 6), a five-day academy of intensive astronaut and mission training for medium-size kids (grades 7 through 9), and an eight-day academy of lectures, training, and career counseling for big kids (grades 10 through 12). They "train" in a 70,000-



*Strolling across Space Camp's Huntsville, Alabama grounds (above), teenage campers make convincing—if giggle-prone—astronauts.*

*An already-buoyant youngster becomes even more so in the spring-activated Moon Walk Trainer (left).*

square-foot warehouse, where various simulators, buoyancy tanks, and other contraptions teach the campers about microgravity and spaceflight while providing them the degree of dizziness youngsters always seem to be seeking. There are also programs for adults and teachers, but for the most part the campers are kids who want to find out what astronauts do and to whom "ET" means External Tank.

All campers in the eight-day version, "U.S. Space Academy Level II," cap off their experience with a 12-hour simulated shuttle



mission, a practicum I had the chance to observe one day last winter, when the participants included 14 Australian students, eight girls and boys from the United States, and one girl from South Africa.

Even though they had been up since about six that morning and had started that early for the past four days of lectures, films, museum tours, and training, the 23 teenagers on the mission were cheerily cooperative at 10 a.m. as the mission began. Commander Jennifer Farone, a senior from Eastlake, Ohio, sat in the left seat of the shuttle cockpit, calling out instructions from her mission handbook to the pilot on her right. At each command, Tony Vitelli, a sophomore from Florence, Alabama, flipped the appropriate number of switches and responded with a crisp "Check." Simulated blue sky and clouds drifted serenely past the shuttle windows. Between checks, Vitelli, exhibiting a proprietary concern for his ship, pointed to my tape recorder. "What's that for?" he asked. When informed that I was working on an article about the academy, he gave me a solemn thumbs-up.

Seated (occasionally) behind the commander and pilot, mission specialist Warren Watson from Perth was giving fellow mission specialist Jason Fewings an impressive imitation of what would happen to their bodies should the shuttle fall on its side, fail to achieve orbit, or otherwise crash. Watson's contortions, strikingly similar to those of cartoon figure Roger Rabbit, continued through a series of commander instructions and pilot checks until another mission specialist, Helen Hernandez, called shrilly to counselor Jeff Wheeler from the

mid-deck, "Who's driving? Is Jeff driving? Jeff, please don't make us crash."

Watson, now composed, turned to me and said, "We have great confidence in one another."

Reading from her manual, Farone spoke confidently into a headset that connected her to Mission Control. "This is the commander. The *Enterprise* is configured to launch."

Meanwhile, some 50 feet away aboard a full-scale mockup of the lab module of space station Freedom, another small crew of cheerful teenagers was thriving. During the previous four days they had received instruction in solar and plasma physics, space biology, astrophysics, remote sensing, optics, and computers; now they were conducting experiments designed to reinforce the lectures.

Lined with lockers and lab equipment, the module was sparsely furnished with an exercise bicycle and a chair in which one could spin. These were in constant use.

As Dire Straits played softly on a tape deck, station commander Carrie Gorman, a 16-year-old licensed pilot from Massachusetts, and her second-in-command, Australian Michael Watts, monitored computer screens that reported the vital statistics of their supposedly fragile (actually plywood) laboratory. Brad Walker, who will attend the University of West Australia in the fall, and his friend Joshua Robins took time out from operating a small robotic arm to show me the splat avoidance vehicle (SAV) Walker had constructed.

At the beginning of the week each camper was given an egg, a supply of flimsy cardboard, balloons, soda straws, rubber bands, nylon stockings, and Elmer's glue and was told to construct a "planetary probe that would protect its payload on landing." The SAVs are dropped from a height of 45 feet on the last day of camp and evaluated. A broken egg disqualifies a contestant, and the winner is the vehicle with the lowest weight and surface area. Walker, who wants to be an engineer, had built a cardboard sphere with straws radiating outward, porcupine-like. Although his career plans aren't focused on space, "if I were offered a job in space, I wouldn't turn it down," he said. "But I'd take any kind of engineering job."

"If you want a job in space, you'd almost have to come to America," added Robins. "There aren't many opportunities in Australia. It's like they say, 'If you invent something, leave the country.'"

*From the glowing confines of Mission Control, an alert team monitors the cavortings of fellow campers.*







*A hapless satellite is "repaired" for the umpteenth time this year (left) during one of the two EVAs each team performs.*

*Space Camp abounds with opportunities to be spun, shaken, and jiggled to the heart's content. In the Multi-Axis Trainer (below), kids learn to orient themselves inside a spinning spacecraft.*

"We've got a leak," announced Watts. A digital display had shown the station temperature gradually dropping, so the campers, prodded by a counselor who was also aboard (and who had programmed the temperature drop from her computer), decided to embark on an EVA—extravehicular activity. Australian Scott Boyle and Bianca Jordaan of South Africa suited up. They spent two and a half minutes standing at one end of the module in the area designated "air-lock," then went through the plywood double doors into the hostile environment of...the warehouse. Five minutes later they reentered, having found a piece of masking tape marked "LEAK" affixed to the outside of the station. No problem. Back to the exercycle.

Glitches like leaks, frozen controls, meteor showers, and dead batteries are zestfully devised by the camp counselors, who otherwise would spend the mission simply hanging around waiting to answer questions for six hours at a time. (The counselors, most in their early 20s, switch shifts halfway through.) Rob Mackintosh sat in front of a





*A Manned Maneuvering Unit mockup gives would-be astronauts a sense of what it's like to walk in space.*





computer terminal in a dark room—Mission Control. “Here’s where we torment all the kids from,” Mackintosh said, tapping what he called “an anomaly” into the computer. The anomalies show up on the terminal screens in the shuttle cockpit and station module. In return, two closed-circuit television screens show the activity in the simulators to the team in Mission Control, where nine campers were keeping track of the shuttle and station systems as well as the health of the crews. Campers always overcome the anomalies, partly because if one turns out to be too thorny, their counselors refer them to the appropriate page in their mission manuals.

During the second half of the mission, after the crews of the shuttle and station had eaten lunch and exchanged places, Warren Watson fell victim to a medical anomaly: hypothermia. Fellow campers wrapped him in a blanket, and mission specialist Allison Goeden from Yankton, South Dakota, generously shared her own body heat by sitting on Watson’s lap. From Mission Control, a message appeared on the station terminal: “Tell Allison that a big kiss will warm him up.” An air of expectation descended on the laboratory. It was dispelled by Jason Fewings, who leaned past Goeden and gave Watson a big smack on the cheek, sending Watson into more Roger Rabbit-like paroxysms and Goeden scrambling to her feet with a shriek that could probably be heard back in South Dakota.

Flight director Gavin Shakespeare, an ebullient redhead from Perth, commanded the control room specialists from a kneeling position in his swivel chair. CAPCOM, as the campers called him (unless they forgot and called him Shakes), would occasionally spin himself vigorously as the group discussed an anomaly, presumably to clear his head. Since the mission was an exercise in make-believe (and since it was 12 hours long), I tried to get into the spirit of things by pretending that what I was observing was real. What if NASA’s real flight director knelt in his chair and gave himself a spin now and then? What if, while astronauts searched for a leak in the ventilation system of a shuttle, ground controllers shouted to them, “Wa-a-a-r-m. You’re warm. No—cold. cold. cold! No. Back the other way. Warmer. Warmer. HOT! HOT!” What if the astronauts used the pockets of their blue flightsuits as a stash for bags of Skittles, SweeTarts, and candy bars? What if the real INCO, the instrumentation



and communications officer, came to work wearing a Walkman and had to be elbowed several times by the CAPCOM to give his input on a systems anomaly? CNN might carry entire missions live.

By the end of the mission, the shuttle crew had docked with the space station, two truss structures had been built during shuttle EVAs, a satellite had been repaired (twice), several leaks had been patched during station EVAs (and one crew member, who forgot his tether, had been rescued), dozens of packages of Skittles had been consumed, many medical anomalies had been faced down, addresses had been exchanged, at least two campers had fallen asleep, and the *Enterprise* had returned safely to Earth. As I was leaving the training center, I ran into Tony Vitelli and congratulated him on completing the mission. Vitelli nodded his head once and stuck up his thumb. ➔

*The space theme extends to the campers’ dorm (above), where signs reading “waste management” and “life support system” mark the bathrooms and heating and cooling equipment.*

*All is serene—for the moment—aboard the shuttle Enterprise as pilot and commander plan their next move.*





# Lovely

In an age when airplanes are designed on computers, it is worth remembering that there was a time when an airplane's shape emerged from the imagination and intuition of its creator. The pertinent adage went: If it looks right, it'll fly right. ♦ Proving once again that exceptions are more interesting than rules, the editors of AIR & SPACE/Smithsonian, with the help of aviation historians and experts, have assembled a short list of random examples of airplanes that were beautiful to behold but, for one reason or another, never succeeded. ♦ For some, it was bad luck or poor timing. For others, beauty was only skin deep; beneath that lovely outline there lived a genuine dog. But all of them share an arresting shape that catches the eye and won't let go. ♦ It's hardly surprising that civil airplanes can be stirringly beautiful—their appearance probably helps to sell them. But even military airplanes, ostensibly form following function in the leanest sense, exhibit a taut shape that we can't help but admire—maximum power in the minimum package. ♦ Many successful airplanes are beauties too, but they have the advantage of being remembered. The ones you see here are more often forgotten.

# Losers





*Bristol Brabazon*

Designed to meet Britain's requirement for an airliner that would serve the important London-New York route, the Bristol Type 167 was also intended to resist an invasion of U.S. aircraft into European markets. The Brabazon was so enormous that the project was delayed because entire villages and roads had to be moved to accommodate its factory and facilities.

Four pairs of 2,500-horsepower Centaurus engines hauled the airplane aloft on its first flight in 1949, after which test pilot A.J. "Bill" Pegg proclaimed that it delivered "a very comfortable ride." He understated the case. The Brabazon could carry 96 day passengers or 52 sleepers in three palatial "saloons," the aftmost comprising an entire cinema, bar, and lounge. But a second prototype, to be powered by turboprops, was canceled, and Boeing Stratocruisers began filling the bill for British Overseas Airways. The

Brabazon's very size may have hastened its demise: although it cruised at 250 mph, its massiveness caused observers to describe its pace as "stately." In 1953 it was scrapped.



*Blackburn B 37 Firebrand*

Considering that Britain's Firebrand first flew on February 27, 1942, it seems inconceivable that this capable and muscular fighter would miss playing a significant role in World War II. But one delay after another kept it out of combat. To begin with, it was denied its Napier Sabre engine by the ministry in charge of aircraft production, which favored the Hawker Typhoon. Then Blackburn was asked to reconfigure it, first as a torpedo bomber and later as a strike fighter with a chubbier Bristol Centaurus radial engine up front. A few of the strike torpedo types saw brief service with No. 708 Squadron from 1944 to 1945, but production terminated in 1947, and in 1953, the Firebrand was declared surplus.





*Bell F.W. Airacuda*

Lawrence Bell's first contract, for a cannon-firing escort fighter that could double as an interceptor, was worth \$400,000, and he gave the U.S. Army Air Corps plenty of airplane for its money. The Airacuda was almost as big as the bombers it was intended to knock down. Its gross weight of more than 18,000 pounds included room for a crew of five and two 37-mm cannon, along with lighter machine guns—all in all, a bit too much for its two 1,150-horsepower Allison. But the airplane's unconventional layout looked futuristic

for its heyday in the late 1930s, and it became a favorite of pulp illustrators. When the bombers it was supposed to escort finally entered service, they turned out to be faster than the 270-mph Airacuda, and ground crews complained that the fighter was a maintenance hog. As if they were nothing but bad memories, all Airacudas were scrapped.

Martin's Model 275 won a 1952 Navy competition for a jet-powered mine-laying aircraft, and Martin built two prototypes for testing. Powered by four Allison J71s, each of which produced 13,000 pounds of thrust with afterburner, the airplane was to roam the oceans and refuel from submarines, serving as the keystone of the Navy's Seaplane Striking Force—an answer to the Air Force's Strategic Air Command. In 1955 the first prototype suddenly nosed down into the Potomac River near Washington, D.C., killing all aboard. The second crashed after a spontaneous loop in November 1956. The concept underlying this sophisticated and beautifully proportioned airplane threatened the Navy's carrier-based fleet as much as it did the Air Force, and by August 1960 the program was terminated.





*Vickers VC10*



*Martin XP6M-1 Sea Master*

Turbofans are more fuel-efficient than straight turbojets, but they're too fat to fit inside a wing. And a clean wing—one that's free of engines—offers room for more flaps and other high-lift devices, thereby allowing the airplane to use shorter runways. The VC10's lovely layout actually arose from such practical considerations. As Vickers' response to a 1957 British Overseas Airways Corporation specification, the VC10 offered six-abreast seating and, eventually, transatlantic range. BOAC ordered 35 in January 1958, and the first airplanes entered service in April 1964. But by then runways in the eastern United States were being lengthened, and despite the Super VC10's added 13 feet of fuselage, which allowed it to carry 163 passengers in quiet comfort, sales fizzled. Vickers was absorbed into the newly formed British Aircraft Corporation, where the focus was on the Concorde. The greatest compliment to the VC10's classic outline came from the Soviets, who copied it with the Ilyushin 62.



The airliner that pioneered the aft-engine configuration is still a beauty. Nearly 300 were built, but Sud Aviation's Caravelle deserved better. The French government ordered it in January 1953, and the prototype first flew in May 1955, with deliveries of 64- to 80-passenger models made soon afterward to Air France and SAS. United Air Lines even ordered some configured for 16 first-class and 54 tourist passengers. The 1962 Concorde agreement between Britain and France distracted both nations, and in 1965, with 173 Caravelles delivered, Boeing announced an airplane that acquired the nickname "Fat Albert"—the far less handsome but faster and roomier 737—and immediately picked up 61 orders from United and Lufthansa. Although the Caravelle's Rolls-Royce Avons were abandoned in favor of Pratt & Whitney JT8Ds, its sales never caught up with the 737 or Douglas' DC-9, and in January 1970, Sud was absorbed into Aerospatiale, which had its plate full of Concorde.



*Sud Aviation SE210 Caravelle*

The company that became Convair spent a great deal of effort streamlining its Model 109—the XB-46—grinding all the rivets flush with the skin and forming the fuselage into a long, slim needle. Designed for a crew of three ("its extremely high speed lessens the need for the several gunners found on conventional bombers," said a company

press release), the XB-46 was competing against several other candidates for the role of medium jet bomber. But Boeing gave its contender, XB-47, something none of the others had: thin wings with radical sweep, which delayed the onset of supersonic shock effects. Handicapped by a 545-mph top speed, the XB-46 didn't make the cut.



*Consolidated Vultee XB-46*





*Arado AR 234 Blitz*

Powered by the same Jumo 004 turbojet engines used by its better known cousin, the Messerschmitt 262 fighter, Germany's Arado AR 234 Blitz was the only jet bomber to see service during World War II. The basic design was clean and simple: a slim fuselage and twin turbojets suspended from a raised wing. The pilot—the only crew member—sat in a plexiglass greenhouse in the nose. The fuselage was so slender (and fuel tanks took up what little interior space there was) that the early models had no room for landing gear to retract. A jettisonable trolley provided wheels for takeoffs and a skid extended for landings, leaving the returned, wheel-less bombers easy targets for Allied fighters. Later models were equipped with retractable gear. Able to outfly Allied fighters, the Arado became an effective reconnaissance aircraft and bomber, but it didn't become operational until September 1944, far too late to turn the tide for Germany.



*Convair XF2Y Seadart*

Few airplanes have ever matched the sheer spectacle of a Seadart taxiing at high speed. The U.S. Navy wanted a supersonic fighter that could operate from remote beaches without aircraft carriers or other visible means of support. New ideas spawn radical solutions, and when the Seadart first took to the water on December 16, 1952, the biggest surprise was something radically

new for flying boats: hydro-skis. As the airplane gained speed, it would rise from its hull onto either a single ski or a pair—Convair tried both configurations. The big 24,000-pound twin-jet fighter with a 60-degree delta wing first exceeded Mach 1 in August 1954, but in November a Seadart exploded in flight, killing its pilot, and the program was canceled in 1956 after only five had been built.





*de Havilland Comet*

When the de Havilland Comet inaugurated jet passenger service on a flight from London to Johannesburg, South Africa, in 1952, the British led the world in the development of jet transportation. The aircraft, its de Havilland Ghost engines installed right in the wings, was a glamorous advertisement for the Jet Age, and people clamored to get tickets for its first commercial flight. Less than two years later the first production Comet, the same aircraft that had made that historic flight, crashed into the Mediterranean on January 10, 1954. When the airplane's wreckage was finally dredged up, investigators discovered that the airplane's outer skin, excessively fatigued by the stress of the pressurized cabin's repeated expansion and contraction, had cracked at a window corner, causing an explosive decompression.

The Comet would rise again as the improved Comet 4, but it was too late. Following the debut of the U.S. Boeing 707 and Douglas DC-8, Great Britain lost its lead in jet transportation.

Intended as a photo-reconnaissance plane for the U.S. Army Air Forces, the Hughes Aircraft Company's twin-engine XF-11 was doomed by a combination of circumstances, not least the mercurial behavior of company president Howard Hughes. Its needle nose, bubble canopy, and long twin booms made it an undeniably sleek airplane, and during World War II the Army Air Forces ordered 100 of them. When the war ended, the order for all but two was canceled. The first XF-11 was equipped with dual contra-rotating propellers on each of its 3,000-horsepower Pratt & Whitney engines. Hughes flew it on its first test flight on July 7, 1946, a day that ended in disaster when the XF-11's right rear propeller reversed its pitch in flight. Hughes crashed into Beverly Hills and was seriously injured. The second XF-11 dispensed with the dual propellers, and the Air Force used it for a time as a trainer. The airplane was ordered scrapped in 1949.



*Hughes XF-11*





*Northrop F-20 Tigershark*

In the late 1970s, the Carter administration grew uncomfortable about the number of countries using top-of-the-line American fighters and decreed that the best ones could no longer be sold overseas. Hence the F-20, which, although designed to be a "second best" aircraft for foreign sales, actually set surprisingly high standards and was cheap to boot. Privately designed, which meant Northrop could bypass the usual thicket of restrictive Air Force regulations, the Tigershark bucked the trend toward ever bigger and more complicated fighters. It was a small (only two-thirds the size of an F-16) and easy-

to-fly single-engine aircraft. The F-20 was based on Northrop's successful twin-engine F-5; in fact, the Tigershark was originally designated the F-5G. The only problem with the F-20 was that nobody wanted it, despite its maintainability and low price. No doubt the crashes of two of the three completed prototypes hurt, but its greatest enemy proved to be the geopolitics that created a global demand for the United States' frontline fighters. When the U.S. Air Force elected not to buy any F-20s, the Tigershark was doomed. The fourth prototype was never completed, and Northrop finally stopped the program in 1986.

Hardly remembered outside Europe, the Airspeed Ambassador presented one of the most pleasing silhouettes ever to grace the sky. The British government only wanted a DC-3 replacement, but the Ambassador grew to a 52,000-pound, 50-seat giant powered by two Bristol Centaurus engines of 2,800 horsepower each. At the September 1948 Farnborough exposition, an Ambassador demonstrated superb control flying on one engine at speeds as low as 130 mph. British European Airways ordered 20 under government duress in 1948, but Airspeed delivered them a year late. Around this time, de Havilland bought into Airspeed, and the Ambassador was soon eclipsed by de Havilland's Comet jetliner. Vickers' Viscount turboprop airliner became BEA's flagship, and by 1958 the Ambassador was pulled from the airline's fleet. A July 1968 accident at Heathrow in which an Ambassador carrying race horses broke a flap link, went out of control, and struck a terminal building caused the type to be grounded, an event that helped seal its fate. —

*Airspeed Ambassador*





# WESTBOUND IT'S ISHITAR, EASTBOUND IT'S HUDSON HAWK. . . THAT'S ENTERTAINMENT?

As is the case with many great cultural innovations, there is some doubt as to who deserves credit for inventing the in-flight movie. The record indicates that sometime in 1925 Britain's Imperial Airways showed a film aboard one of its aircraft, but details of this momentous event have faded. A year later, passengers on a German Air Service Company flight over Berlin were entertained with a showing of *The Lost World*, an adaptation of Sir Arthur Conan Doyle's tale of dinosaurs in South America. Music for the silent film was broadcast to the airplane from a German radio station. "To add to the illusion," reported the *New York Times*, "the plane flew through heavy, low-hanging clouds, making the cabin as dark as a movie house."

Despite that thrilling debut, in-flight entertainment didn't become routine until 35 years later, when TWA began the first regular airline movie service. The idea was the brainchild of a Memphis theater owner named David Flexer, who in 1959 had founded Inflight Motion Pictures, Inc. to market a lightweight 16mm projecting system he had developed. At the time, TWA was locked in a competition with Pan Am, and Flexer persuaded the airline to use his movie service as a way to score some prestige points over its rival, as well as coax passengers into flying first class instead of economy. On July 19, 1961, TWA officially kicked off the modern age of in-flight entertainment, treating first-class passengers flying from New York to San Francisco to a

by  
Tom  
Huntington

*Illustrations*  
by  
Richard  
Thompson

screening of *By Love Possessed* with Lana Turner. "Don't Condemn Her Until You've Seen Her Story!" blared the ad for the movie, which opened in New York theaters the same day.

The movie has been largely forgotten, but the industry it helped launch is thriving. There is now a World Airline Entertainment Association with more than 200 member companies. To keep them informed, the WAEA publishes a glossy magazine, *Avion*, that's packed with ads for onboard audio programs, phone systems, and duty-free shopping services. And once a year the WAEA hosts a week-long conference, the climax of which is a black-tie dinner ceremony to present the association's Avion awards (the trophies bear an unfortunate resemblance to evidence recovered from an airplane crash). At last year's conference, which was held in London, the association even managed to get Prince Edward to present the grandest Avion of them all, the one for best overall entertainment. The winner: Cathay Pacific Airways.

Less than half of WAEA's members are airlines; the rest are companies—headphone makers, movie producers and distributors, projection system manufacturers—that want the airlines' money. And there is money to be had: last year airlines spent a total of \$400 million on in-flight entertainment (or IFE, as its practitioners call it). All for a bunch of stale box office flops? Not according to the IFE vendors who packed the convention hall in London last October: to hear them tell it,



1922 - Dog acts unsuccessful.



1924 - Jugglers no good either.



1933—  
First stand-  
up comedian.  
He bombs.



the industry is poised on the brink of a revolution that could have future passengers reeling from entertainment overload.

One big advance is individual movie viewing, provided by screens installed in seatbacks or attached to armrests. And with advances in data compression, fiber optics, and liquid-crystal display technology, each screen will provide a far better sound and picture—as well as a greater choice—than airline passengers are used to. Virgin Atlantic and British Airways have already installed individual screens; on Virgin, passengers on 747s get a choice of six movie channels, while on British Airways, cabin attendants offer first-class passengers more than 50 movies on video. With airliners equipped for satellite communications, even live broadcasts of sporting events are possible. For the more practical-minded passenger, satellite phone systems will provide many of the amenities of a business office. At the WAEA conference, Lee Seaman, director of international development at Chrysalis Inflight Entertainment Ltd., said, “Airline passengers will have more technology at their fingertips than anyone else. They’ll be able to send faxes, receive phone calls, make hotel reservations from

**On Mideast airlines, says one film distributor, “you can show someone getting his head blown off, but you can’t show him having a drink before.”**

their seat, rent a car, et cetera, et cetera.”

Of course, the airlines aren’t providing all these services out of pure thoughtfulness, but the actual returns they get on their outlays are hard to calculate. “I don’t believe that any of the airlines are actually making a profit from in-flight entertainment,” says Carol Gregoire, WAEA’s president and the manager of in-flight services and amenities for Air Canada. “In some cases, in part costs are supported by revenue from headsets or revenue from advertising or sponsorship, but I believe it’s more an operational cost than revenue. It’s another service that we provide to the customers.” Still, if the airlines can’t recoup the cost directly from IFE—out of headphone rentals, profits from onboard duty-free shopping, and advertising sold in in-flight magazines—they intend to get it by making the flight so enjoyable that a passenger is likely to come back.

But not too enjoyable: In 1990 an attorney aboard a United Airlines flight to Los Angeles insisted on listening to the movie with his own headphones rather than pay the \$4 fee to lease a set. Upon landing, the captain had airport police arrest him for theft. (The movie that caused all the trouble? *Presumed Innocent*.)



Fees aren't the only thing about IFE that can rankle passengers. While a few carriers, such as JAL and American Airlines, have installed some form of individual viewing, most carriers continue to show a single film on a central screen, so selecting a movie likely to please—or at least not offend—all 500 passengers on a 747 is still a considerable challenge for airline entertainment planners.

The process of getting a movie onto a flight begins with a screening cassette. "The studios—the Disneys, Warner Brothers, 20th Century Fox—put out a film that's available for a given month, based on how well it's doing at the box office," explains Bob Brinkman, Delta's manager of media services. "It's generally six weeks after it opens, then it's available for airline viewing. Sometimes if a film is doing better than expected, they may pull it back. That happened with *The Doctor*."

Brinkman screens about 20 to 25 movies a month. He usually does it at home, where he can watch without interruption. "Other carriers, like Swissair, fly into London or Los Angeles for a week of screenings," he says, with perhaps a touch of envy.

Each month, Delta picks an average of two films for domestic flights, two for international flights, and two that are available in two different languages. So what kind of films does Brinkman look for? "Delta

## In-Flight Fare

Each year the WAEA ranks the top in-flight films, based on the number of airline bookings. And the winners are:

### 1991

1. *Home Alone*
2. *Kindergarten Cop*
3. *Class Action*
4. *Russia House*
5. *Ghost*
6. *Three Men and a Little Lady*
7. *Robin Hood: Prince of Thieves*
8. *L.A. Story*
9. *Mermaids*
10. *City Slickers*

### 1990

1. *Driving Miss Daisy*
2. *Turner & Hootch*
3. *The Hunt for Red October*
4. *Pretty Woman*
5. *Bird on a Wire*

### 1989

1. *Who Framed Roger Rabbit?*
2. *Twins*
3. *Rain Man*
4. *Working Girl*
5. *Her Alibi*

is somewhat unique since it's the official carrier for Disney World and Disneyland," he says. "We have a lot of kids. I look for the least objectionable and the most enjoyable movie. We can edit out the language, but I have to be careful of violence, nudity, undercurrents in the tone. *Pretty Woman* was one example. After we screened that we got a lot of letters, 100 to 150, from people who felt that to commend prostitution—we shouldn't do that.... You get an eye for things. Sometimes I'll talk to the studio: 'What's the chance of editing this out, or this?' Sometimes they'll do it. It depends on the studio and the director."

What movies wouldn't make the flight? "It's doubtful that *Terminator 2* would make it," says Brinkman. "Although some of the foreign carriers, like Saudia, wouldn't mind as much." Tastes do differ. Mideast carriers like Saudia may tolerate violence, but they must also honor the sensitivities of their Muslim passengers. On those airlines, says Jeffrey Klein of Jaguar Distribution Corporation, "you can show someone getting his head blown off, but you can't show him having a drink before." And, he says, "you can't show affection." European carriers tend to be relatively liberal about sex, while U.S. carriers will draw the line at what they perceive as excessive sex and violence, or any film that would make flying even more nerve-racking for jumpy passengers.

According to one movie studio spokesman, *Arachnophobia*, a fairly mild horror film about killer spiders, would never make it.

Nor, says Brinkman, would *Die Hard 2*, which features terrorists seizing control of an airport, an airplane exploding on takeoff, and general mayhem in the skies.

And that brings up the hardest and fastest rule of airline movie service:

never show anything bad about flying. The classic example is a scene from the 1988 film *Rain Man* in which Dustin Hoffman's character causes a commotion in an airport because he's afraid to fly.

Though the airlines booked the movie heavily, most decided to cut the scene. But not Australia's Qantas Airways, which undoubtedly got a kick out of Hoffman's mention of the airline's no-fatalities record: "Qantas never crashed,"



1936- Balloon animal demonstration causes near catastrophe.



insists the character, who is obsessed with statistics.

For the airlines, in-flight entertainment's promotional power is sometimes its most important function. Last fall Singapore Airlines added satellite-based phone service to some of its aircraft, even though the service won't turn a profit "for years and years," according to Bob Candiotti of the airline's Los Angeles office. Nonetheless, Candiotti maintains, "the publicity reinforces the image of Singapore Airlines as an industry and technical leader."

Virgin Atlantic, a carrier founded by entertainment magnate Richard Branson, got a lot of press by letting some entertainers ride for free if they performed their shtick for their fellow passengers. In the 1970s some Continental DC-10s were equipped with lounges in which passengers could pass the time on "Pub Flights." When the airline refurbished its lounges in 1982, it re-inaugurated the service by hiring Ella Fitzgerald and her trio to play on board.

Two years ago, the airline's commuter subsidiary, Continental Express, pulled one of the sillier IFE stunts, offering business lectures in the mornings and stand-up comedy in the afternoons on its brief flights between Detroit and Cleveland. "We called it 'Express Yourself Week,'" says Steven Mason, Continental's director of advertising. "It was done more as a promotional thing. There was never any thought to doing it permanently. We needed to call attention to our service, but because advertising rates were so high in the area we couldn't afford to do more than we were already doing."

Continental selected five comedians to do the stand-up aboard the 30-passenger Embraer EMB-120 Brasilia airplanes. On three of Al Aprill's four flights, turbulence was so severe that the seat belt sign stayed on and he had to do his routine as a sit-down comic. "And even when I stood up, I wasn't really standing up," Aprill later recalled. "That's a low ceiling in the cabin. I was sort of bent over." Nonetheless, the program got so much publicity that the airline decided to repeat it several months later on flights



The future.

**Continental Express once tried live entertainment, but turbulence was so bad on some flights that passengers had to settle for sit-down comedy.**

between Newark and New Haven.

Not all IFE innovations fare so well. In 1981 Singapore Airlines experimented with onboard slot machines, using cabin attendants to sell tokens and pay off winners. Unfortunately, the machines had a tendency to break down, and the airline dropped them a year later. "There was lots of publicity," says Bob Candiotti, "but in terms of actual performance, Singapore Airlines did not think it was worth it."

Ironically, the slot machines had been invented by the founding father of in-flight entertainment, David Flexer, and the game's failure marked an unhappy end to what turned out to be a career of diminishing returns. When Flexer founded Inflight Motion Pictures, he had the field to himself, and initially it proved a profitable one. In 1964 the company reported \$1.8 million in earnings, a figure that more than doubled the following year. Then other vendors entered the IFE market, and to make matters worse, they started offering projection systems that were smaller, cheaper, and easily operated by flight attendants. (Although Flexer's system was started by a button in the cockpit, union projectionists had to be hired to change the films at airport terminals.) In 1976 the Securities and Exchange Commission began an investigation of Flexer and his son, and soon after, both were forced out of the company.

If nothing else, Flexer's ups and downs in the field of in-flight entertainment attest to the importance of keeping abreast of new technology. But despite the eagerness with which today's vendors pursue technological advances, and despite the millions that carriers spend to keep fliers entertained, IFE will probably always have an implacable foe. Last year the World Airline Entertainment Association asked passengers to list their three favorite ways of passing the time on long flights, and while 59 percent said they enjoyed watching the movie, a whopping 55 percent voted for the Sandman, admitting they would just as soon sleep. ➔



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*Ocean crossings in the massive 12-engine Dornier Do X and the zeppelins were spectacular but infrequent. Claude Dornier (right) built the Do X and pioneered early flying boat design, but his small, efficient Wal was the airplane better suited to Deutsche Lufthansa's plan to increase the speed of airmail service across the Atlantic.*

At the end of World War II, the United States started a program code-named "Paper Clip." Its purpose was to identify those German scientists and engineers whose knowledge in various fields was deemed valuable. I was one of these Paper Clip people. When we were relocated to the States after the war, we were encouraged to bring along our technical papers, so naturally I took notes and proposals from my position as chief of pre-design with the aircraft division of the firm Blohm & Voss in the city of Hamburg.

I later began to realize that very few people were aware of the scope of what we were working on before the war ended it all. One project, a very large commercial flying boat for the German airline Deutsche Lufthansa, is of particular interest because of its enormous size. With a gross weight of





BETTMANN ARCHIVE

## Germany's Atlantic Air Bridge

**The link to the Americas  
began small, but  
plans called for a big  
finish.**

by Hans H. Amtmann

462,000 pounds, more than a Boeing 767 airliner, it was designed to carry 120 passengers on flights across the North Atlantic. I recently learned that Lufthansa today has no trace of the proposal because the papers had been destroyed by fire near the end of the war. As far as I know, my collection of papers is the only original record of a project known simply as P-200.

I had entered the field of aviation by a quirk of fate. During my studies to become a naval architect, I had taken a course on aerodynamics and was especially intrigued by seaplanes because they combined elements of both ships and airplanes. When I graduated in 1928, the German economy was in ruins and jobs were scarce. I applied for shipbuilding positions



but found nothing. The aircraft industry was no better, but one day I was asked to report to the Junkers company for an interview, which turned out to be an examination. I passed the test with high scores—in fact, the engineer who examined me said I was the first person who'd ever answered every question correctly.

During my four years at Junkers I worked on the G 38, a giant four-engine landplane, and I designed the wing of the Ju 52, which actually started as a single-engine airplane and became a tri-motor to meet airline requirements. The chief engineer was Ernst Zindel, and I worked in an open bay with the others in my design section. Our relationships were rather formal: we addressed each other with the formal "Sie," never the more familiar "du." That custom was fairly typical of a German engineering firm at that time. Junkers was a substantial company and I was lucky to have a job there.

I had arrived at Junkers at a period when several German companies had become interested in finding ways to decrease the time required for commercial flights to cross the Atlantic. As early as 1928, only a year after Charles Lindbergh had made his solo transatlantic flight in the *Spirit of St. Louis*, the German Federal Ministry for Commerce and the airline Deutsche Lufthansa were working on a plan to use airplanes to shorten the time it took to deliver mail across the North Atlantic.

A key to the plan was the oceanliner *Bremen*, scheduled to make its maiden voyage across the Atlantic to New York in the middle of 1929. On that crossing the ship would carry a small mail-carrying airplane and launch it by catapult. Both the catapult and the mailplane, an He 12, were developed by the Heinkel Aircraft Factory in Warnemünde. The catapult was installed high up on the ship's sundeck between the two huge funnels and was powered by compressed air. Its supply line ran through one of the funnels to the machine room, where it was connected to the ship's air compressor. The *Bremen* was scheduled to leave port on July 16. The airplane would be catapulted six days later, when the ship was about 250 miles from New York. As it turned out, this debut flight was anything but uneventful.

Ernst Heinkel and his chief engineer were on board, and according to Heinkel's memoirs, the relations between the



COURTESY HANS H. AMMANN (2)



shipping line, Norddeutscher Lloyd, and the airline were a little strained. Heinkel was under the impression that the director of the steamship company was conducting the catapult experiment on the maiden voyage with great reluctance. The shipping line hoped the *Bremen* would set a speed record for an Atlantic crossing on this maiden voyage, but Heinkel didn't know that—it had been kept secret. The shipping company's reluctance may have been due to a fear that if the *Bremen* had to stop to help out in the event anything went wrong, the transatlantic record attempt could be jeopardized.

According to Heinkel's account, the shipping company at-





tempted to prevent the launch by sabotaging the catapult's compressed air supply. But shortly before takeoff, Heinkel's chief engineer, a man named Schwärzler (Germans rarely refer to colleagues by their full names), discovered that the air line had been broken in an inaccessible place inside the ship's funnel. An angry Schiller, the airline's representative, took the director of the Norddeutscher Lloyd, Glässel, to task. After a heated discussion and reassurances from Heinkel that the launch would go off without a hitch, Glässel permitted the takeoff, although with a minor compromise: the airplane would be launched at the Nantucket Lightship, about

*In 1929, catapult-equipped steamships began launching mail-carrying floatplanes when the ships were about a day from making port. The New York-bound Junkers Ju 46 shown above was photographed as it was launched from the deck of the Europa. On the return trip to Europe, the airplanes were launched off the coast of France.*



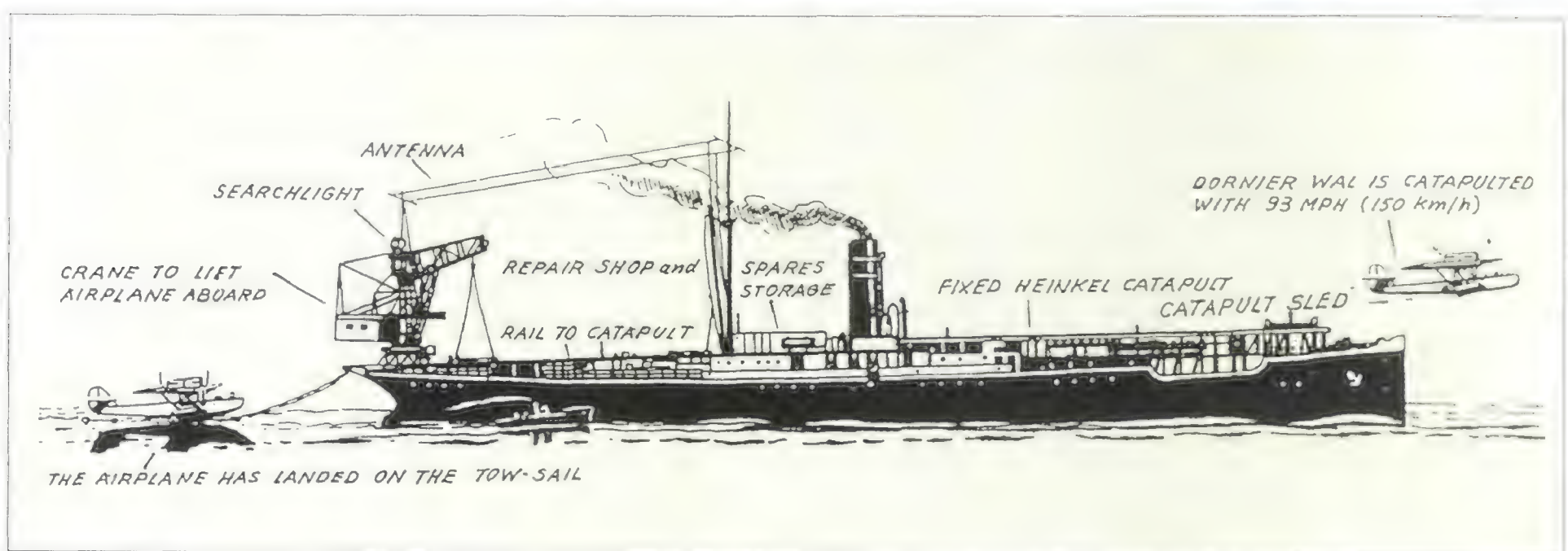
70 miles closer to New York than planned. The lightship was the official mark for the steamship's speed record attempt, and after that point the *Bremen's* effort would not be compromised by the airplane launch. She made it.

On all subsequent trips the airplane was launched at the 250-mile mark and the mail was delivered perhaps a day earlier than it would have been otherwise. On the return voyage the airplane was catapulted five miles west of Cherbourg, France, and flew 500 miles to Bremerhaven, Germany. The service was so successful that in 1930 a more powerful catapult was installed on the *Bremen's* sister ship, the *Europa*, for which Heinkel built the He 58, a slightly larger airplane with a greater payload. In 1932, the Junkers Ju 46 replaced both models.

But far greater savings in time were realized by the mail service to come—across the South Atlantic. There had long been considerable interest in developing delivery service to areas of South America settled by German nationals. The Sociedad Colombo Alemana de Transportes Aéreos (SCADTA), a Colombian company equipped with Junkers F 13 airplanes, had been established with German support in 1919, and five years later it joined with Deutsche Aero Lloyd AG and other interests to form the Condor Syndicat in Berlin. Aero Lloyd was interested in future transatlantic flight from Berlin to South America and SCADTA in connecting South American cities to the United States. Deutsche Luft Hansa (later changed to "Lufthansa") was formed in 1926 by the merger of Deutsche Aero Lloyd AG and Junkers Luftverkehr AG. After a long struggle it would finally establish a transat-



NASA



DEUTSCHE LUFT HANSA

*The floating base Westfalen recovered arriving Dornier Wals after they had powered their way up onto a heavy fabric mat towed behind the vessel (top). From there, a crane lifted the airplane aboard to be serviced and readied for its next launch from the Heinkel catapult (right).*

lantic mail service across both the South and North Atlantic. But the technical hurdles were enormous.

The airline's main concern was safety, and the state of engine development in the 1930s precluded any landplanes from regularly making the long ocean crossing. In fact, until 1933, no airplane built in Germany had the range to cross the entire South Atlantic, even at its narrowest point. By the end of the 1920s several aircraft companies, such as Dornier, Junkers, and Rumpler, were working on large flying boat projects. At Junkers, I was working on a double-hull design that never left the planning stage.



Only the Dornier company had built a really large flying boat: the 12-engine Do X, which made quite an impression in the early 1930s. But the smaller Dornier Wal, a proven seaplane that Deutsche Luft Hansa had flown since 1926 on its routes to Scandinavia across the Baltic Sea, was the economical choice for a staged postal service across the Atlantic.

In 1930, Deutsche Luft Hansa initiated a complex airplane-ship-airplane service. Mail was flown from Berlin to Las Palmas in the Canary Islands, where it was transferred to a ship of the Hamburg South American Line for the trip to Fernando de Noronha, an island off the coast of Brazil. There a Dornier Wal of the Sindicato Condor was waiting for the flight to Rio.

This service cut five days from the delivery time, but the trip still took eight or nine days, and Deutsche Luft Hansa wanted to reduce this even further. After preliminary studies, the airline decided to try stationing a ship equipped with a catapult halfway between Africa and South America to provide an intermediate floating base for seaplanes. The bases provided a kind of mobile airport and maintenance depot. In an emergency, such as a forced landing, the ship could also move out to render assistance. And during launch operations, the forward speed of the ship added to the speed of the wind and made takeoffs with full loads much easier than if they had been made in rough water.

This was a bold venture. The airline had no experience with the larger catapults needed to launch the large flying boats of the Wal series, which weighed three times more than the floatplanes used for the *Bremen* venture on the

North Atlantic. And some means had to be devised to recover the airplane on the open ocean and hoist it onto a ship.

The first "floating base," the *Westfalen*, was a freighter outfitted with a forward catapult and a crane on the afterdeck. Trials were held in 1933 in Bremerhaven, Germany, before the bases of operations were moved to an area off the African coast near Bathurst (now Banjul) and Natal in Brazil. On June 6, 1933, the airline staged a dress rehearsal, and for the first trial runs the *Westfalen* was stationed about 940 miles off Bathurst in the South Atlantic. A Dornier Wal launched from the Gambia estuary on the African coast found the *Westfalen* with the help of the radio direction finder. The Wal was then refueled and launched toward Natal, where it arrived on June 7. A second trial run followed four months later.

The method of recovering the airplane was ingenious: The Wal would run up onto a large fabric mat towed from the ship's fantail. Once the airplane was riding on the mat, lifting it up to the ship took less than 20 minutes. During the trial period these maneuvers were exercised time and again until everybody was satisfied with the operation.

Regular service began on February 3, 1934. A Heinkel He 70, chosen for its record-setting speed, left Berlin with 105 pounds of mail and landed in Seville in southern Spain. Here a Junkers Ju 52 took over; it was slow, but it could manage the rough runway in Africa. It made an intermediate stop in Las Palmas, then flew on to Bathurst on the African coast. The *Westfalen*, with the Dornier Wal *Taifun* mounted and ready on its catapult, waited there in the harbor. The *Westfalen* sailed for South America, and 36 hours later launched





its airplane toward Natal, where a Junkers W 34 floatplane was waiting to make the flight to Rio de Janeiro. Connecting flights went on to Buenos Aires. The entire journey from Berlin to Buenos Aires took about three and a half days.

In the months that followed, the operation put the maximum strain on both the equipment and the crews. In order to keep the service operating at night and in bad weather, the crews had to familiarize themselves with the influence of high launch accelerations on the instruments, which would give momentary false readings. And with the airplanes so close to the water, even a slight loss of altitude after catapulting would have been disastrous. Without a complete mastery of blind launches, a regular operation would never have been possible.

The night and instrument flights were taxing, and illnesses like malaria and yellow fever were also a constant threat. At Bathurst the crews had to improvise shelters in peanut processing plants because there was no other housing. Supplies were often delayed, and the wireless connections were sometimes deficient. Until the runway at Bathurst was covered with steel mesh, the Ju 52s couldn't land during the rainy season, and flying boats had to be substituted for the leg from Las Palmas.

But the mail was delivered rapidly and safely. During the first year, 8,470 pounds was shipped westbound and 5,950 pounds went east. After the service was established, the *Westfalen* shuttled between Bathurst and the mid-Atlantic. During the first year, the airplanes landed on the high seas, but the addition of a second floating base, the *Schwabenland*, and the production of airplanes with greater range allowed nonstop flights between the anchored floating bases. Finally, direct flights could be made to both coasts.

In 1936 Deutsche Lufthansa added a third floating base, the *Ostmark*, as a replacement when one of the existing ships needed to be overhauled. By the end of the 1930s a regular mail service between South America and the capitals of Europe was completely operational. During this period, Deutsche Lufthansa crossed the South Atlantic about 480 times. With every flight about 100,000 letters were transferred. It took the outbreak of World War II to end the service.

In 1936, the company established a regular mail service across the North Atlantic along the lines of the South Amer-



ican operation and using the same cautious, stepwise approach. But the stormy North Atlantic posed problems. The high winds there required a greater fuel reserve, which meant heavier airplanes. The highest gross weight on the South Atlantic had been 24,200 pounds; for the North Atlantic it was 38,500 pounds. And the heavier airplanes required even larger catapults.

First a land base was established in the Azores, with the floating base *Schwabenland* positioned on the route to New York. Dornier Do 18 flying boats, with two Junkers diesel engines of 600 horsepower each, were selected to handle





the route. They made 10 crossings, but because these airplanes had only two engines, they were not considered suitable for a route with unpredictable weather.

The ship *Friesenland* was later built especially for service in the North Atlantic, incorporating all the difficult lessons learned from the South Atlantic service. It carried a large Heinkel catapult for airplanes weighing up to 38,500 pounds and was capable of providing a takeoff velocity of 94 mph. Under certain weather conditions, airplanes had to be carried up to 100 miles farther out to sea by the floating bases. The airplanes might be launched at any time, day or night,

*Dornier's most sophisticated flying boat, the Do 26, had four Junkers diesel engines mounted in tandem push-pull pairs. The aft propellers could be elevated on takeoff to avoid damage from spray. Ordered for nonstop Lisbon-New York mail service and later configured for passengers, these elegant aircraft were sidelined by the war before they ever flew the North Atlantic.*





COURTESY HANS H. AMTMANN (2)

*Hamburger Flugzeugbau, founded by Blohm & Voss in 1933, produced the Ha 139, a floatplane powered by four diesels. At its maximum gross weight of 38,500 pounds, the Ha 139 had to be catapulted because its floats were deliberately undersized to save weight and drag. It could land on the water fully loaded, but it couldn't take off.*

and under the worst weather conditions.

This was a time when other airlines, especially those in England and the United States, became interested in long-distance trans-oceanic operations and began to study transatlantic routes. Despite the competition, Deutsche Lufthansa accomplished the first commercial flights across the North Atlantic. In the summer of 1936, Deutsche Lufthansa initiated service from the Azores to Bermuda, and in October, this was extended on to New York. In the same year, the airline submitted an order to Blohm & Voss (technically, to Hamburger Flugzeugbau) for two long-range four-engine seaplanes capable of carrying 1,100 pounds of mail across the North Atlantic. This order produced the four-engine Ha 139, a twin-float design with four Junkers diesel engines, a gross weight of 38,500 pounds, and catapult capability.

At about the same time the Air Ministry ordered Dornier to develop a fast flying boat with a long range for nonstop flights across the North Atlantic. Dornier responded with the Do 26, which made its first flight on May 21, 1938. In November of that year test flights with catapult starts were made from the floating base *Friesenland* in the Weser estuary at Bremerhaven. The Do 26 never flew the North Atlantic because of the outbreak of the second world war, but it operated briefly in the South Atlantic.

Until the Hindenburg catastrophe in 1937, Lufthansa thought that passenger service should be limited to the zeppelins, which would provide a much more comfortable



voyage than flying boats. The loss of the zeppelins led Lufthansa to order the Blohm & Voss BV 222, a 16-passenger flying boat for the North Atlantic service.

I had arrived at Blohm & Voss from Heinkel, where I worked for only one year after I left Junkers. Hitler's regime was making life difficult for Heinkel. Although his company began to get much more business, Heinkel became the subject of rumors that he was Jewish. He was continually forced to deny these stories, and the atmosphere at the company was not good. I had always been intrigued by the beautiful harbor at my hometown of Hamburg, and I wanted to go back. So I went to Blohm & Voss, where everything was more informal—in part because the chief engineer, Richard Vogt, was such a good man, easy to work with and full of new ideas.

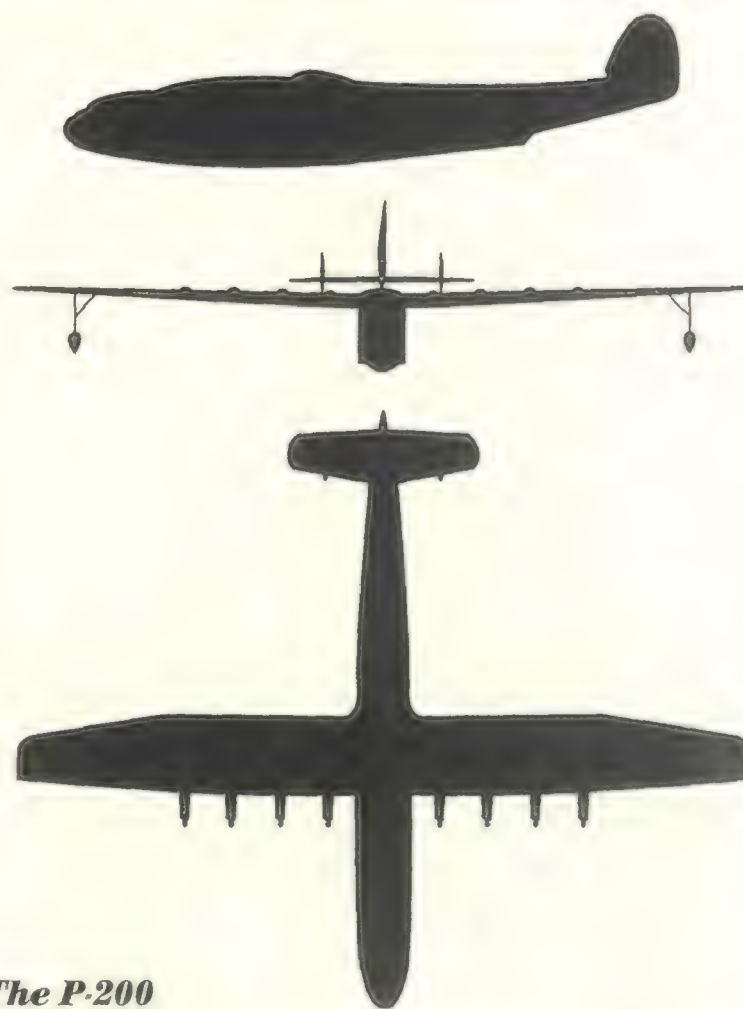
Hermann Blohm and Ernst Voss had started as ship-builders; the battleship *Bismarck* was built in their shipyard. When Voss died, Walter and Rudolf Blohm, Hermann's sons, carried on. Walter was an aristocrat and not easy to deal with, but Rudolf was more of a diplomat. Vogt had been working under Dornier's auspices at Kawasaki in Japan, and when he returned, he helped start Blohm & Voss' aircraft division, which was founded under the name Hamburger Flugzeugbau in 1933. I worked on every Blohm & Voss airplane, from the first to the last.

The airline people would come to the factory and describe what they wanted in terms of passenger load and distance. That determined the amount of fuel, which in turn determined the power. We also had to provide both day and night accommodations for each passenger. Knowing the number of passengers, the size the bed had to be, and the size of the two seats the bed would convert into, it was a simple matter to calculate the size of the cabin and the fuselage. Vogt would make sketches of how he thought an airplane should look. He gave these to me, and I would work everything out.

After the success of the Atlantic mail service, Deutsche Lufthansa wanted to introduce passenger service, and in 1939 the Dornier Do 26 was equipped to carry four passengers. Two years earlier, the airline had come to Blohm & Voss asking for a flying boat accommodating 16 passengers, and we responded with the 110,000-pound, six-engine BV 222. We even built a complete interior inside a mockup of the hull; it was intended for eventual installation in an airplane, but the war intervened before either the Do 26 or the BV 222 carried a single passenger.

Nonetheless, the BV 222 became the most successful airplane Blohm & Voss ever built. It was converted to military use, and it led to the even larger 238 for the Luftwaffe. In its time the largest airplane in the world, the 238 had a takeoff weight of 220,000 pounds. It was tested successfully, but the war ended before a second aircraft could be finished, and the only flying example was destroyed by a U.S. fighter. But both the BV 222 and the 238 served as the basis for the next evolutionary step: project P-200.

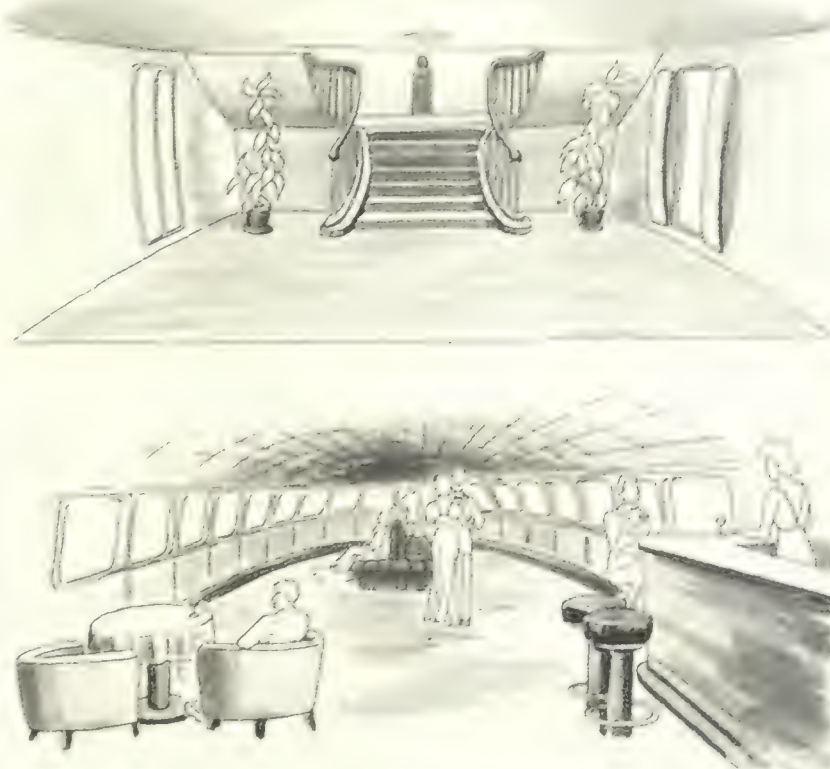
In 1941 Deutsche Lufthansa began to think about the possibilities for North Atlantic passenger service after the war. Things were still going well for Germany—it seemed unlikely the United States would enter the war—and the airline wanted to be prepared for a post-war increase in air traf-



**The P-200**

Truly a boat that flew, the triple-deck P-200 was designed to afford a level of luxury only a steamship could match. A spacious observation parlor located forward on the top deck would offer a genteel gathering place at cocktail time. Passengers could spruce up in their cabins—all had closets and wash basins—before dinner, then promenade to the dining room located amidships via one of the sweeping staircases near the tail. Powering this airborne opulence along its way were eight 20-cylinder liquid-cooled BMW 803 engines, each producing 4,000 horsepower and driving two counter-rotating four-blade propellers. One early cutaway view drawn by the designers even revealed what appears to be a Volkswagen snuggled down in the nose baggage hold.

T. TOOTH/ILAMMANN





*Accommodations aboard the BV 222 mirrored those of long-distance rail travel, with seats converting to berths. The Luftwaffe's BV 238 (right) was, in its time, the largest airplane in the world, and the author (below) argues that the giant P-200 project would have been only an evolutionary step away.*



COURTESY HANS H. AMTMANN (3)

fic across the North Atlantic. The airline asked Blohm & Voss to design a large flying boat for passenger service from Hamburg to New York. We set to work on the proposal, assigning it project number P-200. We submitted the proposal to Deutsche Lufthansa in July 1941.

At the time, the technical staff had a heavy workload due to the war, so the whole thing had to be developed by a minimum number of people fitting it in between the urgent work for the military. Vogt assigned himself to make the first sketches. I took the preliminary layout work, including the weight and center-of-gravity calculations. George Schukat handled the powerplant and equipment. Richard Schubert, our chief of aerodynamics, made the performance calculations. Among this small group, the project was so compelling that we all worked twice as hard as we ever had to ensure its completion.

Vogt sketched out a design for a six-engine flying boat, and he turned his drawings over to me before he left on a well-deserved but short vacation. He had already introduced a number of innovations in Blohm & Voss flying boats, and although the P-200 was very large, with a higher gross weight than Howard Hughes' famous "Spruce Goose," for us it was a logical extension of a series that had led to the BV 238.

At one point during his time in Japan, Vogt had worked for the Dornier company. On one of his visits home to Germany, Vogt had met with Claude Dornier himself, who told him that to become an outstanding designer, one must develop a design feature that would be remembered as one's personal mark. Vogt took the advice to heart, and on his final return trip to Germany, he came up with the idea for the tubular wing spar that would become his trademark. When he started work at Hamburger Flugzeugbau, he incorporat-

ed it into his first design, the Ha 136. Not until aerodynamic considerations forced us to move to very thin wings did we eliminate this spar design.

On the large flying boats, wing thickness was about 20 percent of the chord—the distance from leading to trailing edge. At that thickness, the tubular spar had distinct advantages: not only could it handle the high bending stress experienced when the wing "flapped" under load, it also resisted torsional stress that twisted the wing. The center section was fabricated from welded steel plates and made an ideal fuel tank placed favorably near the center of gravity. Its walls were thicker on the top and bottom, like an I-beam, and the outboard spars were aluminum instead of steel. The BV 238 had such a spar, and the P-200 was intended to have one just like it.

Lufthansa wanted a cabin big enough to carry at least a hundred passengers, as well as lots of room. The airline even wanted a kind of living room, or lounge. At first I could hardly believe it, but I had always wanted to design big ships or big airplanes, and this was just the thing! If we used eight BMW engines of 4,000 horsepower each, we would have 32,000 horsepower available for takeoff. Experience told us that one horsepower could lift 14.3 to 15.4 pounds off the water, so the airplane might weigh between 457,600 and 492,800 pounds on takeoff. In the end, the proposed weight was 462,000 pounds.

On the BV-222, the cabins had been aligned along the long axis of the airplane, head to foot, but Vogt aligned the P-200's cabins transversely, shoulder to shoulder, running in two

rows separated by a passageway. That arrangement resulted in a hull width of a little under 18 feet. We always designed around a length-to-beam ratio of 10, so the hull at the waterline was almost 180 feet long.

Perhaps it was fortunate that Vogt went away for a while. He had envisioned a six-engine airplane, in part because it was thought that eight engines introduced a control prob-



lem: the outboard pair of engines were so far from the cockpit that it was difficult to control the throttles. But Vogt had developed a torsion bar system that eliminated a long run of cables to the throttles, so I added another two engines, and the P-200 came out as a 120-passenger airplane. When Vogt came back, he was shocked at first, but he wasn't angry. He considered what I had done, and he finally decided it made for a more attractive design. The torsion bar system was his, after all, and it was very effective.

There was a staircase to allow movement between the three decks, and baggage was lifted up by elevator into a storage space in the wing. Small auxiliary engines were in





there too, supplying electrical power when the main engines were shut down. I had an artist in my group, and I just let him imagine what it would look like.

Vogt himself wrote the main portion of the proposal presented to Lufthansa, in which he summed up the considerations that had gone into our thinking on the P-200 design. Here is part of what he wrote:

*The North Atlantic, the connecting bridge between the economically important continents, shows by far the greatest traffic density. It is, therefore, understandable that the youngest competitor of the commuter service, the airplane, had wrestled with it already in its earliest course of development. After a number of more sporting undertakings, the years 1937 and 1938 brought a well-planned and fairly regular experimental air traffic with some Blohm & Voss Ha 139s. These successful flights were, for Lufthansa as well as for the Blohm & Voss company, the basis for a farther-reaching step.*

*Only the outbreak of the war prevented the employment of a 16-passenger-carrying flying boat, the six-engine BV 222. The number of passengers on this airplane is, however, negligible compared to the number of passengers which can be carried by the large transatlantic oceanliners. If one considers that over a period of time, a considerable number of passengers would prefer the airplane over the oceanliner, one will recognize that even a 20- or 30- or 40-place airplane would not be sufficient.*

*For understandable reasons it is a natural tendency in technology to simplify operations by going to larger units. One can save a multiplicity of crews and ground personnel and it will*

*simplify the operation. But apart from that, comfort grows with the enlargement of the units. The available space affords such dimensions which, when offered to the public, will soon be taken for granted.*

*If one looks speculatively in such a direction, the choice between landplane and flying boat can only be in favor of the latter. With today's technology and by using every available technical means, it is probably possible to build landplanes of 110,000 pounds to 220,000 pounds in the foreseeable future, but the upper limit for flying boats under the same assumptions is substantially higher.*

*Seen from this point of view, the project P-200 emerged. It represents a synthesis of today's possibilities without special risks: it did not develop from an arbitrary decision to build an X-ton heavy airplane, but from carefully considered results of a number of considerations and of certain assumptions, which were brought under a common denominator.*

He was wrong about landplanes, but he got a lot of other things right. The P-200 was never built, of course, but there was no technical reason why it could not have been. Jet airliners have long since surpassed their early forebears, and with their progress, any perceived limitation of landplanes has been rendered invalid. But many of the ideas contained in the P-200 project foreshadow such developments as multiple-deck passenger aircraft and even the idea of wide-body transports. Most important, it linked the concepts of large size, passenger comfort, and economical operation. The P-200 should not be forgotten. —



## To Mars via Kamchatka

The remote Russian peninsula of Kamchatka, across the Bering Sea from Alaska, is closer to Los Angeles than to Moscow. Nonetheless, it takes at least 24 hours to get there from almost anywhere. It is not just distance that makes Kamchatka remote. Until recently it was kept isolated by Communist regimes. No road connects it to the rest of Asia. For years even mainland Russians faced myriad complications trying to visit relatives in Kamchatka, and foreigners were strictly forbidden.

So why did four U.S. aerospace engineers end up there last August? Because we want to go to Mars.

Surrounded by bountiful fishing areas in the Sea of Okhotsk, Kamchatka, with its lush forests and sparkling rivers, is situated in the midst of the two most active volcanic chains on the planet—at last count there were 29 active volcanoes among the hundreds of peaks. Vast areas are covered by black ash up to dozens of feet deep. The cinder hills, lava flows, and steep cliffs give Kamchatka an otherworldly air—and constitute its main attraction for the four of us, all representing the Planetary Society, a citizens' group that fosters the exploration of Mars. The Soviets had selected the Tolbachik volcano as the terrain in which to test the vehicles they hope will explore the Martian surface later this decade.

In 1990 the Planetary Society organized a test of a Mars Balloon Guiderope system for the French space agency in California's Mojave Desert, and afterwards, Soviet participants asked if we could perform a similar role for the tests of the Mars rover. Because we are a non-governmental organization, our activities consist of unofficial but nonetheless substantial contributions to the project.

Our chief purpose is putting together an international Mars exploration team. I explained to the Soviet participants that while they could build and test their own rover, as could the Americans, it is unlikely that either country will find the money or the political justification for going to Mars alone, with either humans



*The Soviets' rover could overcome obstacles nearly as large as itself.*

or robots. The Soviets have obvious uncertainties and problems, and planetary exploration in the U.S. scheme of things is equally uncertain. Yet enormous talent in each country can contribute a great deal to a relatively low-cost international effort.

Representing the Planetary Society at Kamchatka were Harris Schurmeier, leader of the Society's "Mars '96" team;

aerospace consultant Thomas Heinsheimer; Roger Bourke, leader of the Jet Propulsion Laboratory's moon and Mars exploration studies; and me, the society's executive director. Some fifteen Soviets, from the Mobile Vehicle Engineering Institute, the NPO Lavochkin aerospace industrial organization, the Institute of Volcanology, and the Space



Research Institute of the Academy of Sciences, met us in Kamchatka.

At the onset of our journey, as we reboarded our Aeroflot flight following a fuel stop in Anchorage, we learned that a junta had deposed Gorbachev. The Soviet Far East is indeed far—the political earthquake taking place nine time zones to the west had little impact on our daily life. In the evenings, rather than news, the television featured Armenian and Georgian folk dancing. But I had my shortwave radio and the Soviets had their own way of getting news. We talked about the coup and, after it failed, toasted the changes without being sure of their implications. We were remote observers, as if in orbit, peering down on a clouded surface.

We had to spend two days in Petropavlovsk, the main city in Kamchatka, before we could fly to our test site. It was beautiful in the city, but low clouds hovered over key spots at our site. Patience is a necessary virtue in any field work, particularly in Kamchatka, where the weather for flying is almost always marginal. The Soviets usually spend six weeks every year testing in the area. We could spend only two weeks, and out of that, due to weather, we got a mere two days on site.

During the three-hour helicopter ride to the site, located on the northwest side of the Tolbachik volcano, we witnessed Kamchatka's wild beauty. Bears romped through meadows and fished in rivers. Large thick forests were interspersed with snow-topped volcanic peaks. During rest stops we refreshed ourselves in thermal springs.

Our base was a camp in the village of Kozirevsk, halfway up the peninsula on the Kamchatka River. From there it was only a 15-minute helicopter ride to Tolbachik—or a two-and-a-half-hour ride by four-wheel-drive truck on a mud, dirt, and ash path. At Tolbachik, which is mostly black ash and cinder with some vegetation, a smaller camp with tents and a mess hall accommodated us for one night. The test site, at nearly 5,000 feet above sea level, was all black ash. Boulders littered the slopes, along with rugged lava flows and smooth hills and valleys punctuated by rocky outcroppings. Wood shacks accommodated six sleepers; we also had an outhouse, workshop, kitchen, Ping-Pong table, and the ever-present Russian sauna.

As soon as we arrived at Tolbachik, we drove up to the test site. Rain and low clouds limited our time there, but since we had come more to define test philosophy and requirements than to play

with the rover, this was not a severe loss. The Soviets had installed torque motors on the rover's wheels and wanted to conduct speed experiments as well as examine the effect of different soil properties on wheel motion and torque. The designers also want to use the chassis to measure Martian soil properties and surface morphology.

A team member operated the rover through a remote control box, trying to get a feel for how many independent steps

of the chassis." Only then, he says, will they understand how to control it. In the United States, the design philosophy at the Jet Propulsion Laboratory in California focuses on control and artificial intelligence ("Getting Around on Mars," June/July 1991). Navigation programs are designed and tested in computer simulations before decisions are made on how much autonomy a rover needs—and can use.

Building an international team means



*Building an international team takes more than combining talents and components.*

and controls are needed to navigate different soil conditions and obstacles. The Soviets had wired the model for approximately 200 independent controls, but they insisted that only six or so were necessary to move it. The remaining controls were for engineering experimentation.

The wheels did slip in the soft volcanic ash as they ascended the steep slopes, but the team compensated by changing the wheel base and moving the pairs of wheels independently. The rover also could overcome obstructions nearly as big as itself.

No one knows what a rover will encounter on Mars, so it has to be tested in every conceivable condition. Last spring the Planetary Society organized tests in Death Valley, where we concentrated on soft dunes and alluvial areas, very different from the volcanic regions of Kamchatka.

Lunakhod rover program veteran Aleksander Kemurdjain explained, "We build, test, observe, modify, and repeat many times to understand every element

more than combining talents and components. We spent two weeks with the Soviets in Kamchatka. We dined in crowded tents in the midst of pouring rain, and we talked about the necessity of applying expertise from various nations to our common goal. It was extremely frustrating to hear the Soviets speak of technical problems that are being wrestled with in the United States—and equally frustrating to know that U.S. engineers are struggling with rover design, a field in which the Soviets have done extensive work. But there was a positive note in our discussions: as the republics of the former U.S.S.R. find their footing, openness and interchange are becoming more common. One night, eight of us sat on a single bed in a tent, soaking up the warmth of a small wood stove and talking about the international contacts we helped to establish in volcanic studies and now space engineering. Nationalism in the conduct of space exploration now seems as archaic as Communism.

—Louis D. Friedman



# The Peculiar Behavior of the Heavenly Funicular

This summer, the shuttle will deploy a payload that is a little out of the ordinary. Called TSS-1, the compact Italian-made satellite will leave the *Atlantis* on the third day of the mission and venture out to conduct experiments in the ionosphere. What makes the satellite different is that it will remain connected to the shuttle by a skinny, 12-mile-long cable. Once it has completed its observations, the satellite will be reeled back into the orbiter.

It's an unconventional deployment system, to be sure, but basically TSS-1 (for "Tethered Satellite System") is a fairly modest structure. So modest, in fact, that few will guess that it is the descendant of something far grander and far more ambitious: a vision of physically bridging man and the heavens. The basic idea has been around for nearly a century, and over the years various scientists and engineers have independently designed strikingly different incarnations. But all of the proposed structures have relied on a single common principle: elongation.

The granddaddy of all these designs is a space tower conceived in 1895 by Konstantin Tsiolkovski. A Russian schoolteacher who later formulated the basic principles of rocket propulsion, Tsiolkovski envisioned an elongated satellite whose lower end would extend all the way to Earth's surface, where it would be as stationary as a building. In his paper "Daydreams of Heaven and Earth," Tsiolkovski mused about climbing this edifice. "As one went up such a tower, gravity would decrease steadily," he wrote. "At a distance of 36,000 kilometers, it would be completely annihilated; and then [a force] would be again detected... but its direction would be reversed."

Let's back up a minute and see how such a contraption is possible. First, consider this simple fact of orbital mechanics: a satellite at Tsiolkovski's 36,000-kilometer (22,300-mile) altitude will orbit Earth in exact lockstep with the planet's rotation—every 24 hours. If you position a satellite at this geosynchronous altitude and align its orbit with Earth's equator, the satellite will hover over the

same spot of land 24 hours a day. Now start extending the satellite, building onto both the bottom and the top until the portion below geosynch reaches all the way down to the surface of Earth and the portion above extends up into outer space. At this point the bottom part will be pulled downward by Earth's gravity. But the top part is much farther away from gravity's tug; as Tsiolkovski noted, it will be more affected by centrifugal force, a product of Earth's rotation, and thus will be pulled in the opposite direction. If you've taken care to balance both sections around geosynch, the forces will cancel each other out and the structure will remain perfectly stable.

Tsiolkovski's idea languished until 1960, when a Leningrad engineer, Yuri Artsutanov, took up the cause. In a little-noticed article, Artsutanov proposed an immense "heavenly funicular," or space elevator—a geosynchronous satellite with cables reaching up to the heavens and down to Earth. Since the stresses on such a structure would be greatest at geosynch, the satellite would be the thickest part, with both cables tapering outward until they were a mere one millimeter in diameter.

The advantages of such a structure over a messy, unpredictable rocket are obvious, Artsutanov pointed out. Once you got a payload up past geosynch, Earth's centrifugal force would do the rest, whisking it straight into outer space. (Of course, drawing on our planet's centrifugal force could slow down its rotation a smidgen.)

Writer Arthur C. Clarke eventually got wind of Artsutanov's design, and when he heard that the funicular could launch 500 tons of payload an hour, he was sold. Clarke calculated that if the system were used to transport off-world emigrants, it "could just about cope with the current daily increase in the world population, allowing the usual 22 kg [about 50 pounds] of baggage per emigrant."

Several drawbacks have kept space tower components off the shuttle manifest, however. For one thing, the only material possibly strong enough to withstand the stresses such a structure would be subjected to is pure diamond. And then there's the troubling thought that satellites orbiting below geosynch would eventually bash into the tower.

Never having read Tsiolkovski's or Artsutanov's work, a quartet of U.S. oceanographers dreamed up a similar structure, the "skyhook," in 1966. According to co-inventor Allyn Vine, now retired from the Woods Hole Oceanographic Institute in Massachusetts, the oceanographers routinely worked with low-density cables that, when anchored to the ocean floor, floated upward, and they got to thinking of other uses for such







The Fuller/Clarke Ring City

extended structures. Still enthusiastic today, Vine suggests building skyhook-type launchers on asteroids: "Gravity is low and they're spinning fast, so centrifugal force is high." He also speculates about erecting skyhooks on other planets and moons.

Back when the oceanographers proposed their scheme, no one at NASA had ever published anything along those lines before. Perhaps the notion of space towers and elevators seemed too fantastic to scientists already committed to the rocket technology of the Apollo program. To be sure, some of the skyhook variations had a decidedly science fiction tone. Back in 1951, Buckminster Fuller imagined a sort of circular moving sidewalk that would orbit Earth above the equator. The architectural innovator envisioned "Earthian traffic" somehow ascending to this space ring, jumping aboard for a partial orbit, then hopping off and descending to their equatorial locus of choice. Arthur Clarke later expanded the idea into a habitable "ring city" to which all geosynchronous satellites could be attached, thus facilitating the tasks of satellite maintenance. "It would be reached, of course, by space elevators, which would take the form of several spokes linking the ring city with the equator," he explained.

Clarke was so inspired by space elevators that he made one the star of a novel, *The Fountains of Paradise*. His tower was an invisibly thin filament of diamond capable of hoisting into orbit a few hundred pounds at a time. As a construction material, metallic hydrogen might work better, he later wrote, but unfortunately it's 25 to 35 times more explosive than TNT.

In 1977, Hans Moravec, then at Stanford University, suggested an acrobatic variation on the skyhook. Imagine, he proposed, attaching a large

scoop to each end of a cable stretching several hundred miles. Now set the whole thing orbiting Earth's equator, all the while rotating end over end, with each end briefly touching down on Earth's surface. If you timed everything just right, you could wait at a touchdown spot, jump into a descending scoop, and ride off into space yourself. (Unbeknownst to Moravec, the clever Artsutanov had once again gotten there first, having published the same idea eight years earlier.)

Despite the outlandishness of some of these ideas, NASA and its contractors have begun to see the usefulness of such structures. For missions beyond TSS-1, engineers are studying ways to use small-scale tethers as a reliable, clean, and low-cost alternative to rockets—not Earth-to-space rockets, but smaller boosters of different sorts. In one scenario, devised by mission design engineer Paul Penzo at California's Jet Propulsion Laboratory, an orbiting space station reels out a 1,100-mile cable with a small moon lander at the end. The mothership, at an altitude of 300 miles, and the lander, almost five times higher, begin to circle Earth at the same rate, once every 90 minutes. Because the laws of orbital mechanics say that higher satellites orbit more slowly, the lander will be circling much too quickly for its altitude, so it will end up straining against the cable, much like a pebble in a sling. "If you aim it just right and then release the spacecraft, it'll go right to the moon without using any propellant," says Penzo.

If tethers prove workable, they could even be used to simulate gravity—as much as you want. Ivan Bekey of NASA's office of exploration suggests tying a spacecraft to something heavy, a dead satellite or a used-up rocket tank, perhaps. "You fire the thrusters to get the whole thing to spin, so it looks like a rotating dumbbell," Bekey says. The rotation would produce centrifugal force at each end of the cable, an effect that would feel just like gravity. "You slow down by letting out more tether, so your Gs go down," explains Bekey. "Or you reel it in and you speed up, so your Gs go up—like a figure skater who pulls in her arms and starts twirling faster."

For now, though, most NASA tether scientists are content to reel out TSS-1's little 12-mile string this summer and see what happens. When asked about slingshots and skyhooks, Tom Stuart, NASA's program manager for tethered satellites, responds cautiously. "These ideas are getting a little farfetched," he says. "We probably need to see if we can fly one of these damned things first."

—Doug Stewart

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## Bird Dogs Over the Jungle

**Vietnam Above the Treetops: A Forward Air Controller Reports** by John F. Flanagan. Greenwood Publishing Group, 1992. 313 pp., b&w photos, \$24.95 (hardbound).

These days, almost everybody talks about the Vietnam war as something they'd rather forget. They refer to the experience as if it were a lingering malady, like a bad cold, that the country is finally shaking off thanks to the medicinal effects of the Gulf war. John Flanagan's account of his experiences as a forward air controller in Vietnam is as much out of step with such national mood management as it can possibly be. He's not just here to remind you that there *was* a war in Vietnam, folks; he's in your face with it.

Something made Flanagan mad in Vietnam, and it just won't go away. What got to him was an enemy—not the Viet Cong or North Vietnamese Army but an immorality, an institutional rot that every American serviceman and -woman had to deal with. It was

people on his own side who short-changed Flanagan and his buddies on equipment they sorely needed, the same people who covered their butts with paperwork and sent fiction up to the higher echelons when they craved numbers showing that our side was winning. Then they walked away from the responsibilities they had to the families of those lost in combat. For anybody who participated in those kinds of games, this book should probably carry a warning from the Surgeon General. It is not fun reading.

The author portrays enough of his early upbringing and career to clarify how he got to be the way he is, but most of the

book is devoted to detailed accounts of engagements in the various combat theaters of Vietnam. He underwent his initiation with the forces of the Republic of Korea in the central highlands of Vietnam. Despite their reputation for ruthlessness, the Korean soldiers were attuned to Vietnamese society by virtue of being Asian, and this first experience became a benchmark for Flanagan and his combat philosophy. He later transferred to U.S. units, and eventually began working with the classified Delta

Force, a reconnaissance unit that routinely operated deep in hostile territory.

Flanagan is not a professional writer, but the narrative conveys a certain urgency as he plunges from one encounter to another. He stumbles, though, when he suggests that U.S. forces should not have been limited by geopolitical considerations in how far they could prosecute the war. With thermonuclear triggers backing up both sides of the conflict, politicians had every

### ***Do You Know What Happened to My Brother?***

I examined the map more closely. I was searching for the team once again. Except there was no ground fire. A label sticker had been placed on the original map, coordinates of the helicopter had been written on it, and the map had then been copied and sent to the family. The label was where the team had been—in Laos. But no one really knew where the team had been, except me and the helicopter crew, and they were all dead.

There were no subsequent sights of Russ or Willie indicated in any of the reports. They weren't on any POW lists, compiled from sightings by our released prisoners, or provided by the North Vietnamese government. They were truly MIA. The conversation in the kitchen was animated, uplifting. I wanted to keep it that way. I would hold to my decision. I would tell the truth, without creating false hopes.

"Mrs. Bott, Eleanor, everybody, I think I can give you some information. The best that I know about Russ." I told it all. That I was the last American to talk to them, that I overflowed their position after the helicopter had been driven off by ground fire, and saw nothing but trampled grass. There were no bodies, and two Vietnamese had escaped. I also told them that Stark had been wounded and I thought Russ was OK. I also said that I had personally seen enemy troops and they had all been wearing NVA [North Vietnamese Army] uniforms. The NVA were considered to be well organized and disciplined soldiers

who would recognize the political and military value of capturing American soldiers in Laos. Finally, I showed them on the map where the team was located, the precise location distorted by the label that had been copied onto the map.

I sensed an overwhelming feeling of relief from the gathering. Someone had finally taken away the clouds of uncertainty, the families' efforts had not been fruitless. For them, it was like the burden that had been lifted from my shoulders nine years earlier after the Peace Accord. Some pictures were taken, warm embraces and handshakes exchanged, and I was on my way.

—From *Vietnam Above the Treetops*



*The author flew an  
01-E Bird Dog.*



reason to be nervous about any action that might escalate the fighting.

In his conclusion, Flanagan describes a post-war encounter with the family of an MIA. The family had lived with the lingering question of their soldier's fate, and Flanagan was the last man to see him alive. In what clearly must have been one of the most difficult moments of his life, he told them exactly what he witnessed. In the end, he can take comfort only in sensing that for the family, not knowing the truth was agony. Knowing brought at least some measure of peace.

This book is more than a technical description of what it's like to fly forward air control missions in combat. Flanagan unloads a lot of pent-up rage. He is reportedly considering a run for Congress very soon. Anybody who reads *Vietnam Above the Treetops* will have no trouble understanding where candidate Flanagan is coming from.

—George C. Larson, the editor of *Air & Space/Smithsonian*, was an air operations officer in Vietnam.

**China Clipper: The Age of the Great Flying Boats** by Robert L. Gandt. *Naval Institute Press*, 1991. 214 pp., b&w photos and illustrations, \$29.95 (hardbound).

The era of the China Clipper dawned on October 21, 1936, and ended on December 8, 1941, when a Clipper was strafed at Wake Island. So much was compressed into that brief time: the rise of Pan American World Airways, the aerial conquest of the Pacific Ocean (and of distance itself), the projection of U.S. influence to the rim of Asia, and of course, the romantic saga of the great flying boats. Island-hopping across 8,700 miles

of ocean from San Francisco to Hong Kong with five days of white-glove service!

Pan Am was just one of a dozen airlines flying those beautiful airplanes across every ocean except the one that mattered

most. (The British had insisted on providing reciprocal service, but before they got a passenger-carrying aircraft that could cross the North Atlantic, World War II effectively closed the route.) Robert Gandt covers all the players with an agreeable style and a pilot's eye for detail.

### Encore!

On the 50th anniversary of the Battle of Midway, the Naval Institute Press has published a Classics of Naval Literature edition of *Midway* by Mitsuo Fuchida and Masatake Okumiya, two Japanese naval aviators who participated in the attack. This book enjoyed wide critical acclaim when it was originally published in 1955.

*The Rocket Team* by Frederick I. Ordway III and Mitchell R. Sharpe has also recently been re-published. This in-depth study of Wernher von Braun and his German rocket team has been out of print for a number of years and is now available in a spiral-bound paperback edition from Aircraft Designs, Inc., 25380 Boots Road, Monterey, CA 93940.

Perhaps he is a bit too even-handed: I would have preferred more about the "buccaneer" Juan Trippe, who founded Pan Am in 1927, and less about such marginal competitors as the French.

The same for the photos: I would gladly have sacrificed a couple of Latécoères for a few more Martins or Boeings in service across the Pacific, as the title seems to promise. But those on display are wonderful, as are the scale drawings by J.P. Wood.

The Pacific war put an end to flying boat service. By 1945, U.S. crews had poured asphalt on every conceivable landing spot, including the Clipper stations at Wake, Midway, and Guam, and the U.S. aircraft industry had built thousands of transports with the range and reliability to span oceans without the need to refuel. A few flying boats were still in service in the 1950s and the 1960s, but the economics were merciless. All the passengers who ever flew on the original China Clipper could be accommodated on just 10 flights of a Boeing 747.

In the end, "Clipper" became a word attached to the jetliners that, every hour on the half-hour, shuttled up and down the Boston-Washington corridor, from Logan to La Guardia to National Airport. Now even Pan Am is gone. Gandt's book is a worthy memorial to the airline at the time of its glory.

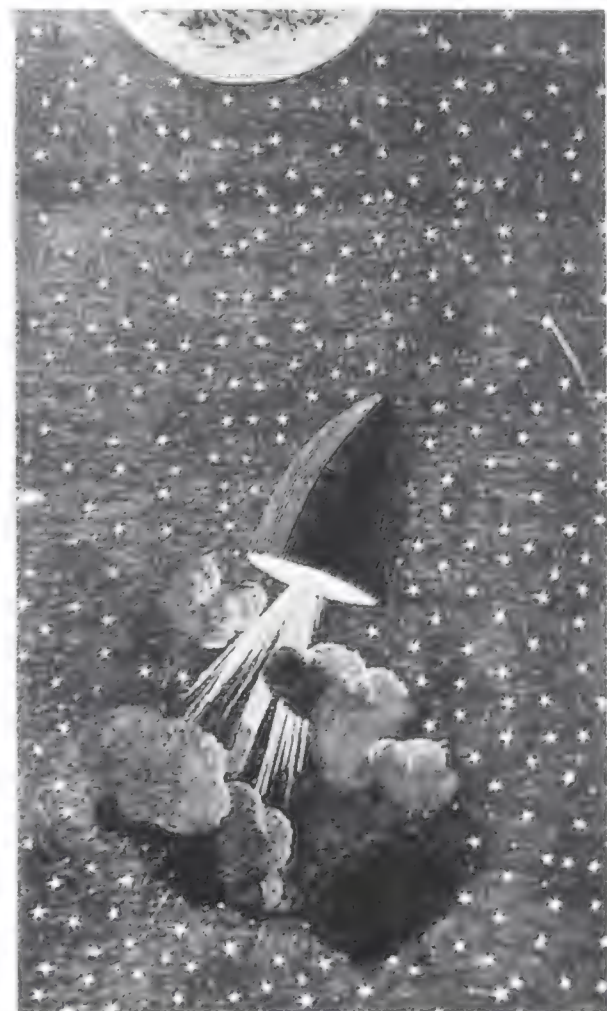
—Daniel Ford is the author of *Flying Tigers*; Claire Chennault and the American Volunteer Group (*Smithsonian Institution Press*, 1991).

**Blueprint for Space: Science Fiction to Science Fact**, edited by Frederick I. Ordway III and Randy Liebermann. *Smithsonian Institution Press*, 1992. 224 pp., b&w and color photos and illustrations, \$60 (hardbound), \$24.95 (paperback).

To late 20th century ears, the words "space travel" have a familiar ring, yet this phrase would have boggled the imaginations of our ancestors. *Blueprint for Space* surveys how space travel evolved from dream to reality in science, literature, and art. Twenty-three authors—including astronauts, science fiction writers, space artists, and space scientists—contribute to a narrative that accompanies a rich collection of images.

The earliest evidence that humans were aware of the moon, stars, and other entities beyond Earth is found in cave art, appropriately where *Blueprint for Space* begins its story. Through the centuries, visions of space and space travel grew increasingly realistic, although the vision's evolution was not without its fantastic detours. In an amusing 17th century parody of space travel, Cyrano de Bergerac writes of his attempt to propel himself to the moon by using vials of dew (he had observed that the sun draws morning dew off the ground). By the late 19th century, however, Jules Verne

Jules Verne's imagination took 19th century readers to the moon.



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seemed downright prophetic. Soon science fiction pulp magazines were regularly taking readers to the moon. What might be the seminal act of consciousness-raising in space travel was unveiled in the 1950s in a series of articles in *Collier's* magazine (and later in a trio of films produced by Walt Disney studios). This vision of space exploration would have an inestimable effect in attracting support for the U.S. space program.

Midway through the narrative, the theme shifts from science fiction to science fact. The book traces the history of rocketry, beginning with 10th century Chinese skyrockets and continuing up to rocket pioneer Wernher von Braun and his V-2, which paved the way for the

Saturn V that took us to the moon. By the time Apollo astronauts reached the lunar surface, however, the United States had begun to scale back its space efforts.

While trips to other planets have seemingly been put on hold, there are those who still dream of space travel. In the book's final essays, several of today's visionaries, such as astronaut Sally Ride and artist William Hartmann, offer their own ideas of our future in space. In today's belt-tightening time, we may find those visions difficult to believe. But so did readers of *Collier's* in the '50s.

—Andrew Chaikin wrote "Shoot for the Moon" in the December 1991/January 1992 issue.

**How They Fly the Concorde**, produced by Paul Havis. Distributed by Eye-in-the-Sky Television (800-228-7470), 1991. 50-min. video, \$24.95 (plus \$3 shipping).

So what if it's cramped, loud, and a money loser? The Concorde has a cachet—and a speed—that no other airliner can match. And even though it's been flying for more than 20 years, it still looks like something from the future, more like a spaceplane than a commercial carrier. Which is one of the reasons why people are still fascinated by the world's only operating supersonic airliner.

"How They Fly the Concorde" is designed to address that appeal. Originally made for a projected cable TV series called "Great Air Routes of the World," the episode has been expanded considerably for this video. At times the stretch marks show, particularly in an opening explanation about the video's episodic origin, as well as a much-too-long sequence about Kennedy Airport. But then things get rolling, and except for a few cabin interludes that wouldn't be out of place in a British Airways promotional piece, the video delivers just what its title promises: everything from initial ground inspection at Kennedy to touchdown on Heathrow's runway.

Host (and producer) Paul Havis, a 747 captain himself, also takes us on some painless tutorial side trips along the way. We learn something about the design of the Concorde

and how it differs from more conventional airliners. There's a brief—if slightly superficial—lesson about

supersonic flight as well. But the real buffs are going to be interested in the cockpit sequences. It's all quite informative and educational. Thrilling too, especially when the throttles are slammed forward on the runway, the



afterburners roar, and the airplane leaps down the runway before taking off on a flight that will exceed twice the speed of sound. That's what the Concorde is really all about. You may not be ready to take the controls of one after viewing this video, but you should gain a renewed respect for the aircraft.

—Tom Huntington is the managing editor of *Air & Space/Smithsonian*.

**The American Space Shuttle from Landing to Launch**, produced and directed by Brad A. Lawrence. Brad Lawrence Productions (407-453-0882), 1991. 32-min. video, \$19.95 (includes shipping).

What sets this documentary apart from others about the space shuttle is that it begins where the others usually end,



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**Skyliners: Mainliners, Falcons and Flagships** by George W. Hamlin, photography by Mel Lawrence. World Transport Press (800-875-6711), 1991. 118 pp., color photos, \$24.95 (hardbound).

Anyone who spent time on an airport observation deck during the 1950s and '60s will think they've opened a time capsule when they get into this book of color photographs. This was the era when air terminal ramps were alive with a mix of DC-3s, Convairs, Martins, and Electras. Both Boeing and Douglas had one foot in each world, with their propeller transports as well as jets in service with Pan Am and Delta. Blue oil smoke mixed with the soot from burning kerosene.

with the double sonic booms that announce the shuttle's approach to its runway after a successful mission.

A montage of five- to 15-second television clips supplied by NASA, the video explains how the shuttle's three major components—boosters, external fuel tank, and orbiter—come together for launch from the Kennedy Space Center in Florida. Producer-director Brad Lawrence makes a technical ballet of the "stacking" process in which the winged ship is connected with its bulbous tank and candle-like rockets inside the cavernous Vehicle Assembly Building. The film is an astonishingly professional production, considering that Lawrence—a video technician with Lockheed Space Operations Company, the main shuttle processing contractor—made it in his spare time at home.

Aimed at educating young people, the video has a few minor problems. The biggest one is its assumption that the audience already knows at least a little about the space shuttle. What's missing is a graphic naming the craft's different parts and orienting viewers in what they're about to see.

Even adult experts, however, will find something of value in this film: although it has only one five-second shot of the interior of the firing rooms, launch controllers who have seen the video say it provides an excellent backstage tour of Kennedy's normally off-limits operational areas.

—Formerly editor of Spaceport News, Beth Dickey writes about the space shuttle for the Reuters News Service.



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And those wacky paint schemes! Airliners looked like billboards ("FLY EASTERN"), except for Braniff's fleet—"the end of the plain plane"—which reminds you of your first complete set of Crayolas. The text is brief, offering sparse detail that usually includes the fate of various airplanes. To use a phrase straight from that time, this book is a trip.

—George C. Larson

**Gunship 2000** by Microprose Entertainment Software, Inc.  
Available for IBM AT, PS/S, PS/2, IBM compatibles, and Tandy with 10 MHz. DOS 2.1 or higher. Supports VGA/MCGA Graphics. Joystick optional. Reviewed on IBM compatible with super VGA screen. \$49.99.

**Nighthawk F-117A Stealth Fighter** by Microprose Entertainment Software, Inc.  
Available for IBM 386 and compatibles with 16 MHz. DOS 3.0 or higher. Supports VGA/MCGA Graphics. Joystick optional. Reviewed on IBM compatible with super VGA screen. \$59.99.

A remarkable improvement over its predecessor, "Gunship 2000" offers a variety of challenging helicopter combat scenarios. Player control of up to five gunships is available with navigation computers, tactical screens, and an optional copilot. Redesigned graphics include intricate ground detail for low-level flying, as well as enhanced effects depicting combat damage to the helicopter's lift, hover, acceleration, and torque controls.

"Nighthawk F-117A" exceeds Microprose's technically proficient design standards with an impressive graphics package. Radar-cloaked bombing missions are featured in nine combat scenarios. The Microprose-designed F-117A contains navigation and tactical screens, heavy armament, and radar visibility indicators. A more realistic version of the F-117A is also available, but with reduced combat capability.

—Ken Isbell is a technician at the National Air and Space Museum's Paul E. Garber restoration facility.

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## Calendar

### June 8-July 3

Composite Aircraft Construction Workshop. Indian Hills Community College, Ottumwa, IA, (515) 683-5183.

### June 12-14

Moonlite Fly-In. Porterville Municipal Airport, Porterville, CA, (209) 781-0706.

### June 13 & 14

High On Kalamazoo Airshow. Golden Knights, Pepsi Skydancer, and Red Baron Squadron. Battle Creek International Airport, Kalamazoo, MI, (616) 381-8237.

### June 16 & 17

Diamond Jubilee Celebration. Thunderbirds and Golden Knights. Selfridge Air National Guard Base, Mount Clemens, MI, (313) 466-5196.

### June 18-21

International Miniature Aircraft Association's Rally of the Giants. Richards-Gebaur Airport, Kansas City, MO, (913) 631-6346.

### June 20-25

Universe '92. 104th Annual Meeting of the Astronomical Society of the Pacific. University of Wisconsin, Madison, WI, (415) 337-1100.

### June 20-29

National Aeromodeling Championships. Sponsored by the Academy of Model Aeronautics. Westover Air Force Base, Chicopee, MA, (215) 592-8601.

### June 26-28

Ultralight flying competition. Brooks Field, Marshall, MI, (616) 781-4241.

### June 27 & 28

Quad City Airshow. Davenport Municipal Airport, Davenport, IA, (319) 285-7469.

### July 9-12

International Plastic Modelers Society National Convention. SEA TAC Red Lion Hotel, Seattle, WA, (206) 232-7784.

### July 11 & 12

Central New York International Airshow. Oswego County Airport, NY, (315) 592-2004.

### July 17-19

Air Heritage 92. A celebration of Jimmy Doolittle's World War II raid on Tokyo. Wichita Mid-Continent Airport, Wichita, KS, (316) 943-5510.

# AIR & SPACE

## Offers Back Issues

**April/May 1986.** Premiere issue! Biplanes, airships, chase planes, Vandenberg Air Force Base.

**June/July 1986.** Scientific V-2s, Ariane's launch facility, Bryan Allen's pedal power, flying boats.

**August/September 1986.** Space plane, sky-writing, microbursts, dragsters, New Guinea gold rush.

**October/November 1986.** Dragonflies, DC-3s, the Sun, HAM.

**December 1986/January 1987.** The F-16, JPL, moon origins, homemade satellites.

**February/March 1987.** Astronaut artist, sailboats, searching for *L'Oiseau Blanc*.

**June/July 1987.** *Top Gun*'s role model, Floyd Bennett Field, Hubble Space Telescope, Thunderbirds, rocket belt.

**August/September 1987.** Nazi space plane, the Go Team, Wright brothers, pigeon racers, looking back to the Big Bang.

**October/November 1987.** Space toys, carrier operations, Chinese MD-80, Project Vanguard, mapping Mars, High Gs.

**December 1987/January 1988.** Captain Midnight, Schipol airport, Soviet polar flights, balloons over Africa, UFOs.

**February/March 1988.** Swedish air force, NASP head, wind tunnels, BASE jumping, blowing up rockets.

**April/May 1988.** X-29, "Space Explorers" poster, India's space program, airplane food, P-40s for China.

**August/September 1988.** Reef encounter, Piaggio, NASA photos, Air National Guard, supernova, G.M. Bellanca.

**October/November 1988.** Mojave Airport, "The International Airplane" poster, L-5 Society, Lear Fan, nuclear spaceship.

**December 1988/January 1989.** X-1 engine, mini-space station, Galileo, soaring.

**February/March 1989.** B-52, Scout rocket, baggage handling, space art.

**April/May 1989.** Kenya by balloon, Paris Air

Show, Energia, ejection seats.

**June/July 1989.** Special Apollo issue! "Apollo 11" poster, Saturn V, how we got to the moon.

**August/September 1989.** The C-5, LDEF, parachutes, Japan, Pan Am's Pacific, Kansas space museum.

**October/November 1989.** Mars propulsion, World War II's black pilots, spacesuits, flight in the funnies, Burnelli.

**December 1989/January 1990.** Autogiro, Voyager 2, Antarctica, weightless life, Robert McCall.

**February/March 1990.** The Japanese Zero, Salyut 7, Magellan, around the world with a camera.

**April/May 1990.** Nuclear cruise missile, meteorites, Lindbergh, nose art.

**June/July 1990.** Battle of Britain I, life in Star City, satellite sleuths, solar-power satellites.

**August/September 1990.** Target drones, Battle of Britain II, spearing a comet, destroying Soviet missiles.

**October/November 1990.** The Blackbird, going to Mars, Air & Space Museum, Battle of Britain III, space shuttle.

**December 1990/January 1991.** Sound barrier, Cosmodrome, X-rays, collision avoidance.

**February/March 1991.** Blimp, Life on Mars?, Rivets, electronic warfare.

**April/May 1991.** Space shuttle poster, ultralights in Egypt, X-31, lifting bodies, kamikazes.

**June/July 1991.** Mars rovers, Jimmie Angel, P-51, beyond the shuttle.

**October/November 1991.** World War I fighters, asteroids, F-86 pilot, airmail.

**December 1991/January 1992.** Moonbase, spysats, cocaine wars, Biosphere II, models.

**February/March 1992.** Pararescue, Admiral Yamamoto, nuclear rockets, Skylab.

**April/May 1992.** Reno races, speed poster, Big Bang theory, satellite rescue, the Shack.

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## AIR&SPACE

## Credits(& Further Reading

**Getting Out.** Fred Reed has written for *Harper's* and other national magazines.

**Out of Shape.** Ellis Weiner's book *Letters from Cicely* was recently published by Pocket Books.

**Happiness Is a Hot Jet.** Stephan Wilkinson, an *Air & Space/Smithsonian* contributing editor, decided during the course of researching this story that he would graciously turn down any offers of rides in surplus military jets.

Chad Slattery is a frequent contributor to *Air & Space/Smithsonian*.

**You Are Here.** Frank Kuznik is a frequent contributor to *Air & Space/Smithsonian*. His most recent article, "Birdmen Come to Cleveland," appeared in the April/May 1992 issue.

**The Beach House.** Mike Mullane retired from NASA in 1990 and currently lives in Albuquerque, New Mexico. He travels extensively to speak on his spaceflight experiences.

A specialist in remote photography, Scott Andrews has photographed nearly every shuttle launch.

**I Was a Teenage Astronaut.** *Air & Space/Smithsonian* senior editor Linda Shiner did not have the opportunity to attend Space Camp as a teenager, but her parents did offer on occasion to put her in orbit.

For more information, write U.S. Space Camp, One Tranquility Base, Huntsville, AL 35807.

**That's Entertainment?** Tom Huntington is the managing editor of *Air & Space/Smithsonian*. He was once entertained for an entire flight by trying to open the bag of peanuts.

Freelance cartoonist Richard Thompson has had his work published in the *Washington Post*, *National Geographic*, and *U.S. News & World Report*.

Further reading: "Airline Connections," Christopher O'Malley, *Popular Science*, March 1992.

**Germany's Atlantic Air Bridge.** Hans H. Amtmann is retired and lives in Southern California.

Further reading: *Lufthansa: An Airline and Its Aircraft*, R.E.G. Davies, Orion, 1991.

*The Vanishing Paperclips: America's Aerospace Secret, A Personal Account*, Hans H. Amtmann, Monogram Aviation Publications, 1988.

**To Mars via Kamchatka.** Louis Friedman is the executive director of the Planetary Society.

**The Peculiar Behavior of the Heavenly Funicular.** Doug Stewart has contributed articles to *Omni*, *Discover*, and *Health*.

Further reading: "The Space Elevator: 'Thought Experiment,' or Key to the Universe?" Arthur C. Clarke, *Advances in Earth Orientated Applications of Space Technology*, vol. 1, no. 1, 1981.

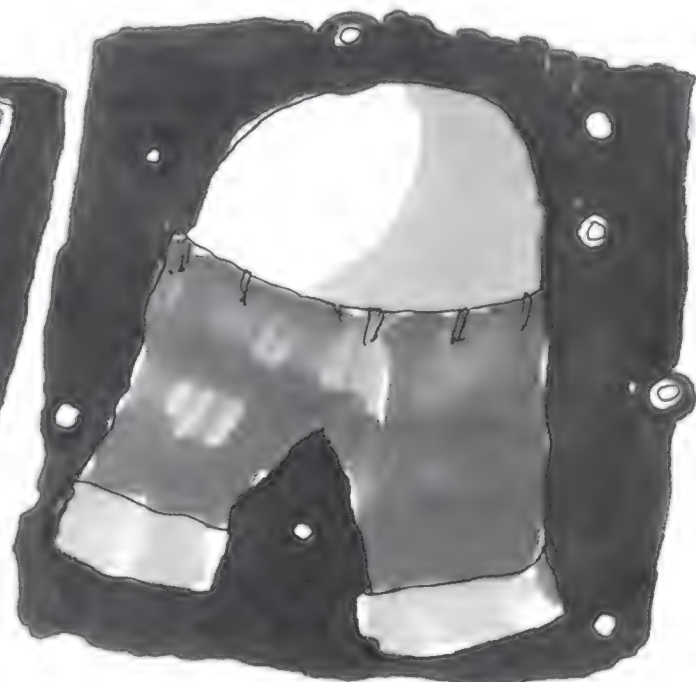
**Ground Zero.** David Savold is an associate editor at *Air & Space/Smithsonian*.



VENUS  
IN  
BLUE JEANS



SATURN  
IN  
BLUE JEANS



JUPITER  
IN  
BLUE JEANS

Cartoon by




# "The Satellite Sky" Update/30

These regular updates to "The Satellite Sky" chart will enable readers to keep their charts up to date. Additions can be clipped and affixed to the chart at the appropriate altitude.

## New launches

### 90 to 300 MILES


 **Cosmos 2182**  
4-1-92 PL

 **Cosmos 2183**  
4-8-92 TT

 **Soyuz TM-14**  
3-17-92 TT

### 300 to 630 MILES

 **Cosmos 2180**  
2-17-92 PL

 **Cosmos 2181**  
3-9-92 PL

### 6,200 to 13,700 MILES


 **GPS-12**  
2-23-92 CAC


 **GPS-13**  
4-10-92 CAC


DATA: SAUNDERS KRAMER

### 21,750 to 22,370 MILES

 **Arabsat 1C**  
2-26-92 KOU

 **Galaxy 5**  
3-13-92 CAC

 **Gorizont 25**  
4-2-92 TT

 **Superbird B-1**  
2-26-92 KOU

### Inoperative but still in orbit

#### 300 to 630 MILES

Cosmos 2100

#### 630 to 1,250 MILES

Cosmos 2004

### 21,750 to 22,370 MILES

Fleetsatcom 2  
Gorizont 16

Meteosat 2  
Westar 4

### Launched but not in orbit

#### 90 to 300 MILES

STS-45 U.S.  
research

3-24-92

down 4-2-92

## Deletions

### 90 to 300 MILES

Cosmos 2075  
down 2-20-92

Cosmos 2153  
down 3-13-92

Cosmos 2175  
down 3-20-92

Gamma 1  
down 1-28-92

Progress M-11  
down 3-13-92

Soyuz TM-13  
down 3-25-92

### 300 to 630 MILES

Astro-C  
down 11-1-91

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## Forecast

### In the Wings...

**"Gentlemen, I Give You the Whittle Engine."** Under siege by Germany and frantic to enlist the vast manufacturing capacity of the United States in the war effort, the British government shared a secret with the Americans in 1941. The gift of the turbojet turned out to be the commercial advantage of the century.

**Looking at Earth.** If you can't see the forest for the trees, spacecraft can provide a broader view.

**Let Them Eat Snake.** Survival training no longer teaches pilots to live off the land, but it can keep them alive until the rescue team shows up.

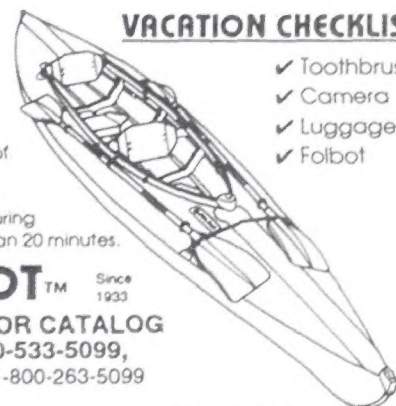
**The Mystery of Amelia.** A scrap of aluminum and the heel of a shoe—what do these really tell us about the fate of Amelia Earhart? And what makes the International Group for Historic Aircraft Recovery so sure they've found her?

**High Performance.** The Blue Angels make it look easy, but they work devilishly hard.

**Little Space Probes Have Big Ears.** For 25 years NASA's Deep Space Network has tracked the spacecraft studying the solar system. Now the network is tracking more spacecraft than it can handle, and the situation can only get worse.

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## Collections



JOHN HEINLY

## Ground Zero

The jackrabbits in this part of the Tularosa Basin didn't stand a chance that July morning in 1945. Pre-dawn twilight had barely touched the pointy stalks of the yucca when the first man-made nuclear weapon was detonated, producing temperatures that momentarily exceeded those on the surface of the sun.

The resulting mushroom cloud left south-central New Mexico with a somber legacy. Opened to the public in 1953 and declared a national historic landmark in 1975, this remote desert location is now something of a tourist attraction. Known as Trinity Site, it's posted with warnings of radiation and rattlesnakes and is open only twice a year.

Early one spring morning I set out from Albuquerque in a rental car for the place that Manhattan Project physicist Robert Oppenheimer had been inspired to name while reading the poetry of John Donne. Following the interstate and the Rio Grande south through the Land of Enchantment, I sifted through dim recollections of *Dr. Strangelove*, John Hersey's book *Hiroshima*, and air raid drills at my elementary school in the 1960s. After an hour or so I turned east toward the desert basin that Spanish missionaries and explorers called Jornada del Muerto—the Journey of the Dead.

Once the hunting grounds for Geronimo and Billy the Kid and in the early 1940s part of the government's Alamogordo Bombing and Gunnery Range, this isolated area was chosen as the Manhattan Project test site over seven other contenders in California, Texas, Colorado, and New Mexico. The Spanish had given the area its gloomy name because of the arid geography and Indian attacks, but the first man-made nuclear explosion gave the name new meaning. Now the land is part of the Army's White Sands Missile Range, and soldiers in fatigues wave the cars, family wagons, and RVs into orderly rows in a parking lot.

The eastern border of the Jornada is dominated by the Oscura mountains. A smaller chain, 20 miles northwest, includes Compañia Hill, where Nobel

laureates, generals, and other VIPs had gathered to watch the blast. In the darkness they had rubbed on suntan lotion to protect themselves from the flash.

A dusty road stretches from the parking lot to a large fenced-in expanse of desert scrub and a ten-foot-tall lava obelisk that marks ground zero, the point directly below a nuclear explosion. All that remains of a 100-foot tower that housed the plutonium bomb are gnarled stumps of steel. At 5:29:45 a.m. Mountain War Time on July 16, 1945, after a 90-minute delay for bad weather, the steel tower was vaporized by the detonation of "the gadget," which produced a blast equal to 18,600 tons of TNT. Windows shattered 120 miles away. "I remembered the line from the Hindu scripture, the Bhagavad-Gita... 'Now I am become Death, the destroyer of worlds,'" Oppenheimer later wrote. Army officials told the public that a munitions storage area had accidentally exploded.

Today, tourists in Bermuda shorts and sun hats stroll around ground zero and examine the remains of a concrete piling that had supported the tower. Some pose for snapshots next to a replica of a bomb casing. Others stoop over the scrub in search of the green, glassy radioactive substance known as trinitite, which was formed when the immense heat from the blast melted the sand. A pamphlet warns visitors that trinitite "is still radioactive and must not be picked up."

A woman from the White Sands radiation protection office sat at a table with pieces of trinitite and a geiger counter that gave off a sound like radio static. She demonstrated that everyday objects—a ceramic plate, a radium clock dial, a gas lantern's mantle—also contain radiation. "You probably get exposed to more radiation during a dental X-ray [than during a Trinity Site tour]," she reassured the sightseers.

Most of the trinitite was hauled away by the Atomic Energy Commission when the shallow crater was filled in the early 1950s. A shelter still protects a portion of

the original crater, but little else suggests the six-mile-high mushroom cloud that shocked the sky that morning. Today, Trinity Site could double for a Georgia O'Keeffe landscape.

School buses shuttled visitors from the parking lot to the old adobe ranch house where the bomb had been assembled. (Jeeps had been stationed outside for a quick escape in case of any unforeseen developments.) Disembarking at a sign that cautioned "Beware of snakes," visitors patiently lined up to see the makeshift clean room where scientists had put together the two hemispheres of plutonium and an initiator. Hanging on a wall is a framed copy of a 1939 letter Einstein had written to Roosevelt, which led to the establishment of the Manhattan Project ("Sir: Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future").

It was almost noon when I was shuttled back to the parking lot. Vendors were hawking T-shirts, coffee mugs, and other souvenirs bearing "Trinity Site" inscriptions. The mercury was pushing 80, and several elderly women had raised umbrellas against the sun.

I had plans to meet friends that night in Santa Fe, and it was time to return to the hotel. By coincidence, I was staying at the same place that had housed some of the Manhattan Project scientists 47 years ago. After spending the morning at ground zero, it wasn't difficult to conjure up their presence. As I walked by the Spanish-decor bar in the lobby, I could picture them—Enrico Fermi, Hans Bethe, and the others—gathered together, not wanting to be alone on the eve of the atomic age.

—David Savold

Trinity Site, White Sands Missile Range, New Mexico, 88002. Phone (505) 678-1134. Open 9 a.m. to 2 p.m. first Saturdays in April and October. Admission free.





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